

1991 TRAFFIC SAFETY IMPROVEMENT STUDY

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Traffic, Transportation & Civil Engineers

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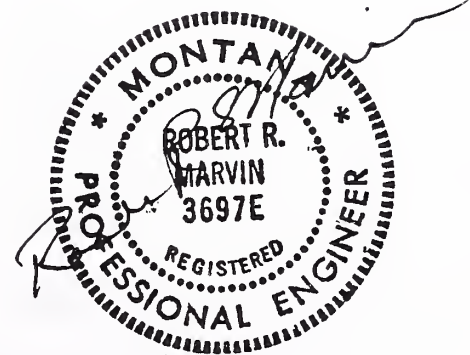
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INTRODUCTION

STUDY PURPOSE

The City of Great Falls, in an effort to reduce or otherwise alleviate problems at accident cluster sites on the City street system, had retained the Consulting Engineering Firm of Marvin & Associates to perform a traffic engineering study. The purpose of this study was to identify accident cluster locations, collect and analyze pertinent data, make short and long term safety improvement recommendations and establish a priority list of improvement projects.

Other studies using similar methods had been completed for Montana counties with the technical and fiscal assistance of the Montana Department of Justice, Highway Traffic Safety Division. The intent of the Highway Traffic Safety Division in sponsoring studies on county roads was to reduce accidents on county road systems and to establish an awareness of accident reduction measures so that a continuation of the program could be established within each county. After a decade of such work, Highway Traffic Safety has shifted its emphasis to city street systems. This is the first such study to be completed within Montana's Cities.

Since most major cities in Montana have traffic engineers and technicians on staff and are benefited by other safety programs, the intent of the safety improvement study is somewhat different. Much of major urban area street systems are designated as Federal Aid Routes. The classifications range from Primary Highways to Federal Aid Urban streets. These streets are usually urban arterials and collectors which have high traffic volumes. Monitoring accident data and traffic volumes; developing improvement projects; planning new facilities; and maintaining the system, is usually handled by the City and State. Programs such as the TSM Element of the Transportation Planning Process and the Montana Department of Transportation's Safety Program adequately cover most of the safety problems within Montana's major cities. Day-to-day operations on the street system cover accident problem areas as they are brought to the attention of the city staff through citizen complaints or police instigated investigations. The intent of this study is focused on

those locations which may not be included in any of the formal State or City programs. All of the accidents site are on streets which do not fall under Federal Aid classifications and are commonly known as "Off-system" streets. Some of the study sites may be at locations that the City has monitored and implemented controls, but have defied efforts at improving safety. The majority of sites are usually low volume streets which have had minor, but consistent accident problems. Because of a low number of accidents per year, these locations are not readily recognized as accident cluster sites. When subjected to intense analysis as contained in this study's methods, large benefits from simple inexpensive improvements at these locations can be recognized. Thus, the purpose of this study is to identify accident cluster sites on Off-system city streets; recommend improvements; prioritize site improvements; and introduce cities to the methods used in this type of analysis.

The methodology used in these studies, which primarily served as the basis for the analysis within this report, can be found in the report *No. FHWA-RD-77-83 "Identification of Hazardous Locations"*. Refinements to the FHWA report made by *DCA Project No. 79-04-01-01* and subsequent county studies throughout the state, are also incorporated within this report. The methodology used to establish priority rankings is explained in the Benefit/Cost Ratio section of this report and is tailored specifically to the City of Great Falls' unique requirements.

Funding for implementation of traffic safety improvements contained within this report will qualify for the Montana Department of Transportation, Off-system Safety Funds. Because of this, priorities and funding obligations are specifically tailored to MDoT requirements. Upon approval of this program by the City of Great Falls, this report should be submitted to MDoT as justification for Off-system Safety fund allotments.

REPORT ORGANIZATION

The initial section of this report contains narratives describing the accident cluster site locations, characteristics of the city street system, study methodology, results of the hazard index analysis for all of the sites, explanation of the improvements

recommended, priority index calculations, an implementation schedule and recommendations for continuation of the program in future years. Special attention should be given to the Site Characteristics and Explanation of Improvements sections, since specific traffic safety information for the Great Falls street system is presented in these sections.

Site specific data can be found within the individual site sections following the main body of this report. Site specific sections contain brief narratives regarding site conditions, observed problems, and recommendations. Also included is an accident summary page, 35mm pictures of the site, and supporting information as required.

A great deal of computer generated data was printed and reduced for inclusion on the existing condition and short term improvement sketches. The availability of pertinent data on the same page as the sketches hopefully aids in comprehension of the problem identification and improvement benefits. The short term plan sketches can also be used by the MDoT to verify the traffic control device items eligible for funding through their program. These sketches, being too voluminous for inclusion within this report, are bound separately as a plan package. Any references to existing conditions or short term improvements within this report can be found in the that document. The 11"x17" plan sketch book can also be used by the City Street Department in the future, as a set of plans for actual implementation of most improvements.

The site specific sections of this report are numbered according to their priority ranking as indicated in the site location section of this report. Twenty five (25) sites are included in this project, as per the contract budget. Some of the sites were located in close proximity along single streets. In addition, other sites identified during the screening process indicated that some streets have accident problems at almost every intersection and significant numbers between intersections. At these locations a general evaluation of the corridor was completed. In this case, the Central Avenue and 9th Street S. corridor are discussed within the main body of the report.

SITE CHARACTERISTICS

SITE LOCATIONS

The map on the following page (Figure 1.) shows the twenty five accident sites numbered according to their respective priority numbers. Table 1., below, is a listing of site numbers corresponding to the site locations:

TABLE 1. LIST OF STUDY SITES

SITE NO.	AVENUE	STREET
1	SEVENTH AVE S	13TH STREET S
2	FIFTH AVENUE S	13TH STREET S
3	EIGHT AVENUE S	10TH STREET S
4	NINTH AVENUE S	9TH STREET S
5	ELEVENTH AVE S	29TH STREET S
6	EIGHT AVENUE S	7TH STREET S
7	FIRST AVENUE S	8TH STREET S
8	FIFTH AVENUE N	11TH STREET N
9	EIGHT AVENUE S	9TH STREET S
10	SECOND AVENUE S	9TH STREET S
11	THIRD AVENUE S	8TH STREET S
12	SECOND AVENUE S	23RD STREET S
13	THIRTEENTH AVE S	9TH STREET S
14	FIFTH AVENUE S	23RD STREET S
15	CENTRAL AVENUE	9TH STREET S
16	THIRD AVENUE N	4TH STREET N
17	SECOND AVENUE S	4TH STREET S
18	FIRST AVENUE S	PARK DRIVE
19	SECOND AVENUE S	2ND STREET S
20	ELEVENTH AVE S	26TH STREET S
21	SIXTEENTH AVE NW	5 - 6TH ST NW
22	FIFTH AVENUE S	7TH STREET S
23	CENTRAL AVENUE	7TH STREET S
24	CENTRAL AVENUE	4TH STREET S
25	THIRD AVENUE S	46TH STREET S

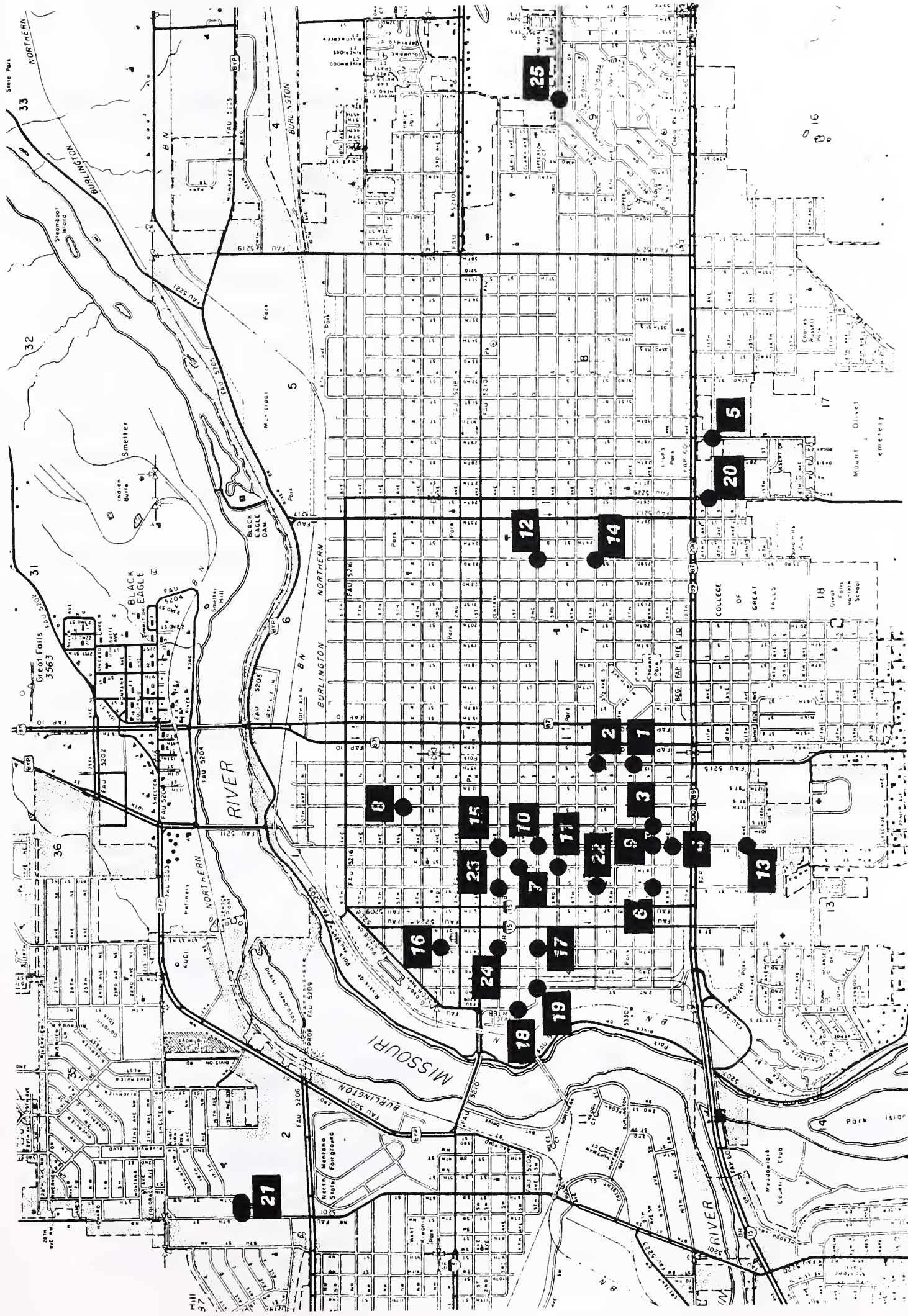


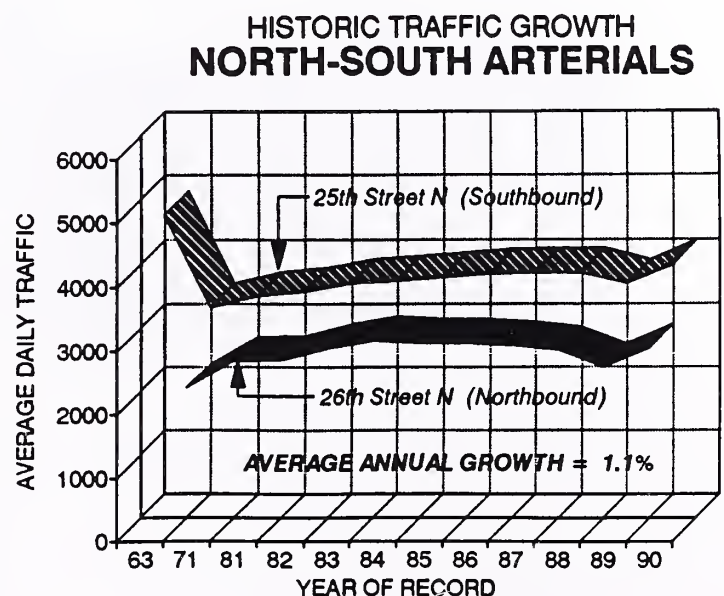
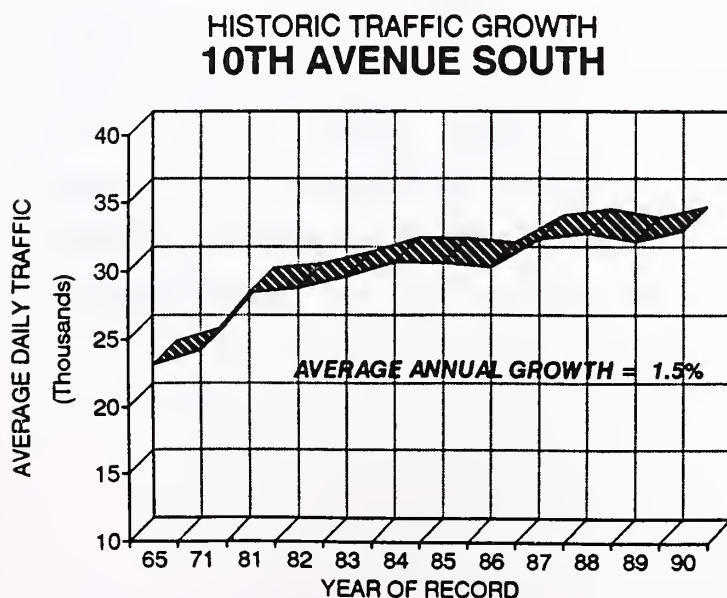
FIGURE 1. SITE LOCATION MAP

SYSTEM CHARACTERISTICS

Traffic Volumes - All of the accident sites are located in a completely urban environment on relatively low volume streets. The highest traffic volume at any site is approximately 15,000 vehicles per day entering an intersection, while the lowest volume is approximately 1400 vehicles per day entering. The average of all sites is approximately 4,500 vehicles per day entering. Average Daily Traffic (ADT) on all of the streets involved is approximately 2,200 and ranges between 13,400 and 300. The City of Great Falls provided numerous past traffic counts at or near the study sites. The Montana Department of Highways monitors traffic on 10th Avenue South and some north-south arterial streets. This information was used to develop factors in estimating ADT's at the study sites.

Historical Factors

Data provided by the City of Great Falls indicated that traffic volumes on city streets have remained fairly constant over the past four years and in a significant number of cases, traffic has decreased. MDoT's permanent count stations provided the most reliable indication of traffic growth in the urban area, historically. Data from those stations provides general, long range trends in traffic growth. Figure 2, below, illustrates traffic growth thru 25 decades on 10th Avenue South and on north-south arterials. Generally, traffic is growing at an annual rate of approximately 1.0 to 1.5 percent.



Monthly Variations

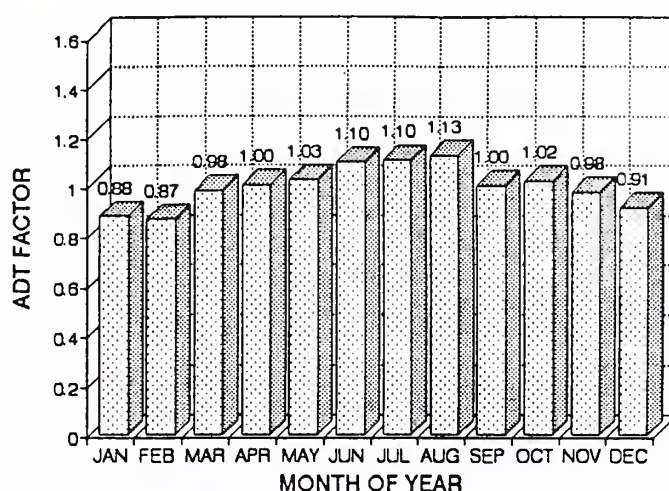
A key factor in estimating average daily traffic is the month of the year. Traffic tends to vary significantly depending on the weather, seasonal economy, school sessions and various other reasons. Monthly variations provide an accurate reflection of seasonal conditions.

Figure 3., right, illustrates monthly traffic variations for 10th Avenue South and north-south arterials within Great Falls. Data used in preparing these graphs was extracted from MDoT's permanent count station records.

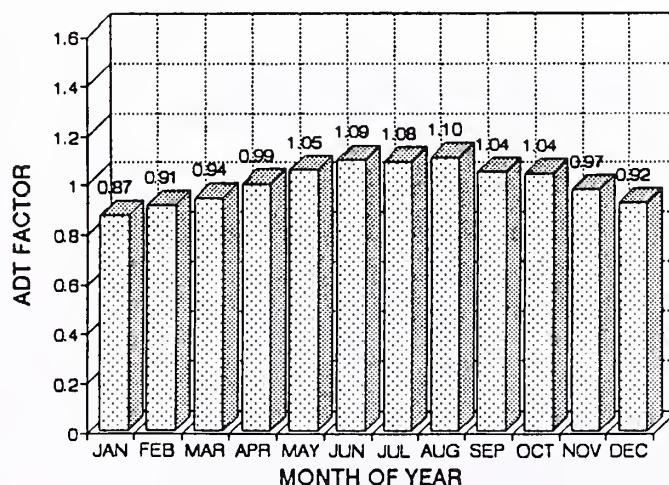
There is very little difference between the monthly variation graphs which indicates that seasonal variations are fairly homogeneous throughout the city's major street system.

August is the highest volume month, with approximately 111% of the average monthly traffic. January is the lowest traffic month with ADT's being about 87% of the average month.

MONTHLY TRAFFIC VARIATIONS
10TH AVENUE SOUTH



MONTHLY TRAFFIC VARIATIONS
NORTH-SOUTH ARTERIALS

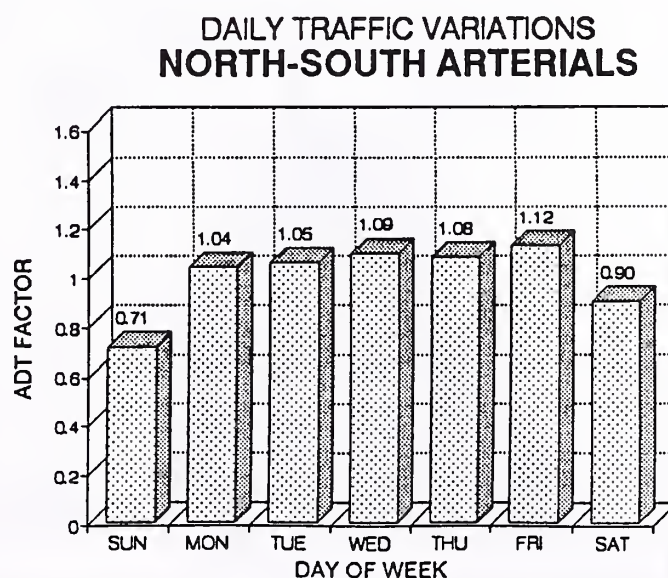
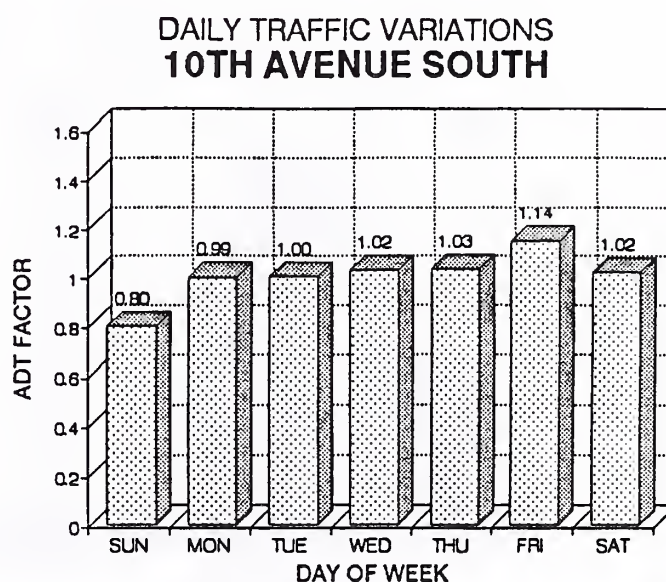


Daily Variations

Traffic volumes vary significantly according to the day of the week and play an important role in estimating average daily traffic. Factors derived from extended traffic counts are not usually as reliable as monthly or seasonal factors due to the smaller time frame. Special holidays and events tend to skew daily variations. As an example, Monday holidays tend to have lower traffic than normal while the following Tuesday has higher than normal traffic.

Figure 4., right illustrates daily traffic variations in Great Falls. This data was again extracted from MDoT's permanent count stations.

There appears to be a significant difference in 10th Avenue South and north-south arterial traffic. Average weekday traffic is much higher on the north-south arterials while weekend traffic is much lower. This illustrates the differences in adjacent land use and street function. Tenth Ave. S. has intense commercial development which attracts free-time shopping trips and non-local traffic. The north-south arterials have little adjacent commercial development and serve typical business day trips with a full range of purposes.

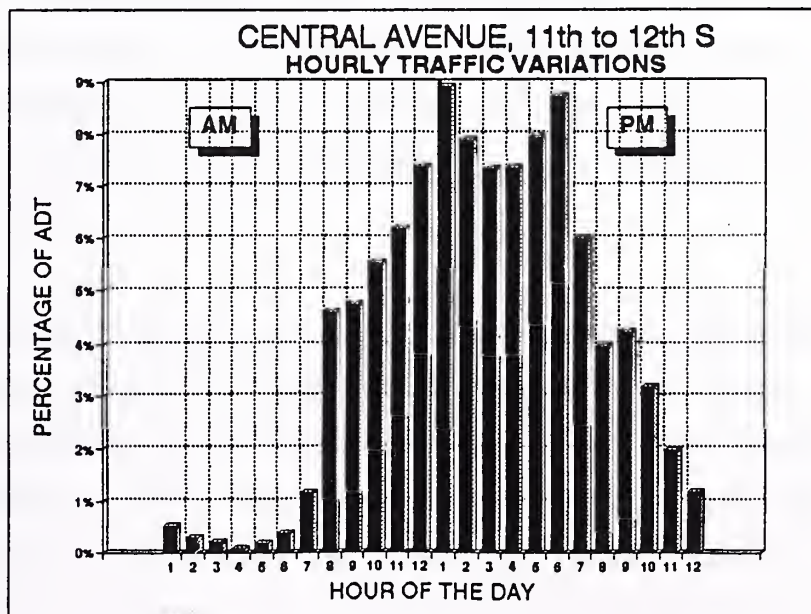
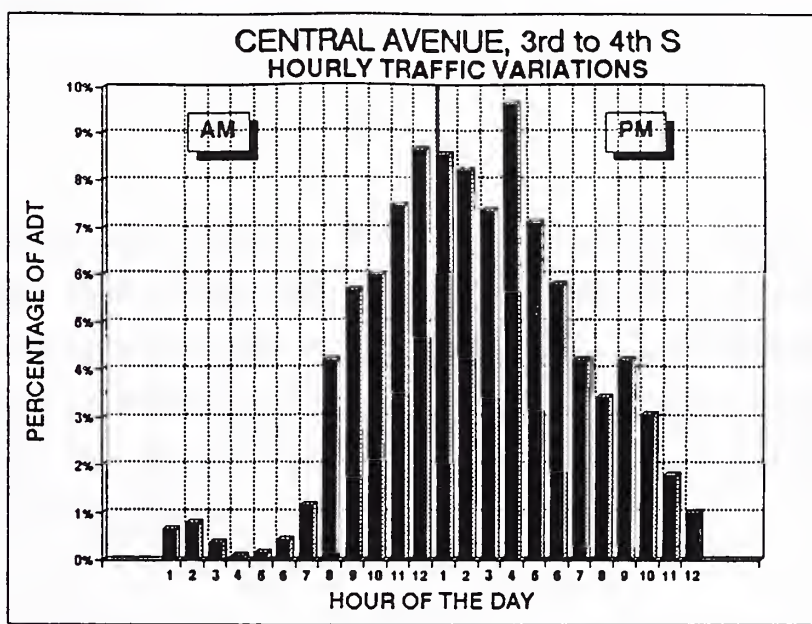


Hourly Variations

Variations in traffic volumes by time of the day is highly predictable since there is rarely any significant differences from one weekday to the next, at any one location. However, differences between various types of streets and locations can be vastly dissimilar. Twenty four hour machine recording counts on the same or similar streets are necessary to accurately estimate ADT's from shorter period counts.

Figure 5., right, presents hourly traffic variations on Central Avenue at two separate locations. These are only two of numerous hourly count summaries prepared from data provided by the City of Great Falls.

Both graphs have the same basic shape, but the CBD count has the highest peak (4-5PM) which would indicate a higher concentration of employment in the CBD than the fringe area. The count between 11th and 12th also has more defined noon and evening peaks as would be expected.



Street Characteristics - The Great Falls City Street System is laid out on a grid system with numbered Avenues running east and west and numbered Streets running north and south. While the grid system provides simple four legged intersections and a rational manner of referencing addresses, it can also have some disadvantages. Arterial and collector streets run parallel and perpendicular to local streets and in many cases, with the same extent of continuity. As long as the arterial and collector streets carry traffic demand at an adequate level-of-service, there are no problems. When demand exceeds design level-of-service and increased travel times and delay are perceived, traffic begins to spill onto adjacent local streets. This problem was noted in the area around 10th Avenue South. Traffic volumes on local side streets are inversely proportionately to the distance from 10th Avenue South. Also, accident clusters are more notable within two blocks of the main arterials.

Physical characteristics of the streets are typical of most western cities. There is a mixture of old and new roadway design standards and access control. The majority of street surfaces could be classed in the poor to fair range. It is believed that some accident experience may be indirectly related to rough and uneven street surfaces. In some cases, asphalt has deteriorated to the point where pavement traffic marks could not reasonably be applied.

A common problem observed at the study sites, involved lack of parking controls near intersections. While many of the sites had signs and and yellow curb marks most of the local residential streets did not. This is entirely understandable, since it is very costly to mark every intersection when 90% of the time there are no apparent problems. Even when an accident problem surfaces, it is very difficult to attribute it to a mobile sight restriction.

Another common observation at local intersections was the roadside environment relating to trees, hedges and fences within in the intersection sight triangle. While the City of Great Falls does an excellent job of keeping trees trimmed, tree trunks in the boulevard areas are so large that they create an intermittent sight restriction which may or may not be related to some of the angle accidents. These type of blind spots can sometimes be more hazardous than a large imposing sight restric-

tion because motorists are not consciously aware of the brief loss of sight.

Traffic Control Devices - Some degree of traffic control devices were present at almost all of the sites. The applications range from street name signs to traffic signals. Most of the signs and markings were applied correctly according to the Manual on Uniform Traffic Control Devices (MUTCD), however some problems seem to be consistent throughout the city. The most obvious problem noted was a lack of positive guidance on the major street system. A significant number of major intersections are either missing street name signs or they are mounted at inconsistent locations. This can become a major safety problem for motorists not familiar with Great Falls. In this situation, a large portion of the drivers cognitive powers are directed toward navigation. When there is little positive guidance provided, critical driving mistakes can be committed because little conscious ability remains for the other varied driving tasks.

Damaged and faded signs were noted throughout the city. While not a very large percentage of total signs fall into that category, those that were noted were extremely ineffective. The City of Great Falls has a complete sign inventory and management system. Through this system, signs are replaced on a priority basis as budget allows. It is recommended that the City assess their current practises to determine if lower priority signs need to be replaced after a maximum period of time in the sign's life.

There are numerous traffic signal installations within the City of Great Falls. Most of those signals are on the Federal Aid System and some, including four within the confines of this study, are exclusively within the city's jurisdiction. While many problems could be cited with some of the On-system signal installations, there are only a few specific problems with the City's signals that can be noted. Most obvious is the corner pole top installations on Central Avenue. This old style signal is completely inadequate for modern traffic operations and even the simplest modification could not be recommended without replacing the entire system. More specific information on these signals is provided in the section dealing with the Central Avenue Corridor.

A common problem noted with the newer mast arm signal installations focus mainly on pole location and signal head location and alignment. At the two study intersections of this type, there appeared to be no correlation between mast arm lengths and lane alignments. Signal heads are mounted in most unlikely locations, while there is a lack of consistency in signal indication types and vertical placement. There also appears to be concerns regarding mounting of signs on mast arms because of wind loading. Use of advanced lane control signs mounted on poles and masts provide some help, but only to the small percentages of the drivers who actually need the information and were cognizant of the signs before they reached the decision point.

Traffic Accidents

Traffic accident characteristics for all of the Great Falls study sites are summarized below:

Category	Total	Average Per Site
Total Number of Sites	25	NA
Total Number of Accidents	248	9.92
Study Period in Years	3.16	3.16
Traffic Volumes Entering	NA	5920
Accident Rate /MVE	NA	1.97
No. of Injuries	76	3.04
No. of Fatalities	0	0
Severity in 1000's \$	1213	48.52
No. Angle Accidents	129	5.16
No. Rear End Accidents	43	1.96
No. Sideswipe Accidents	29	1.16
No. Pedestrian Accidents	4	0.16
No. Single Vehicle Accidents	9	0.36
No. Left turn Accidents	8	0.32
No. Parked Car Accidents	21	0.84
No. of Other Type Accidents	5	0.20

Of all the years in this period, 1988 had the least number of accidents (59), while 1990 had the most with 102. If 1991 accident statistics were projected from the first two months of the year, the number of accidents for the entire year would be approximately 75 accidents, or about the same as 1989. The predominant trend appears to be increasing accidents at the study sites. Angle accidents were the most common accident type, which accounted for the relatively high number of injuries. Most of the accidents occurred in clear weather on dry roads. Night time accidents were not as common as daytime accidents. No fatal accidents occurred within the study sites. Alcohol involvement played an insignificant role, since only 3% of the accidents involved drivers who had been drinking.

Future System Characteristics - Great Falls has an approved transportation plan which outlines certain transportation improvement projects to be constructed within the next twenty years. None of the short term improvements recommended within this report will have any significant effect on the implementation of long range transportation project. At least two of the study sites, the intersections of 26th Street S. & 29th Street S. with 11th Avenue S., provide short term solutions to problems which would be better served by more capital intensive long range projects. Specific long range recommendations are made in the site specific sections of this report.

STUDY METHODOLOGY

The study was segregated into four distinct phases which best achieved the purpose and scope of the traffic study. These phases are outlined as follows:

Phase 1, Site Selection - involved copying all of the accident reports on Great Falls city streets for the years 1988 thru February of 1991 from Department of Justice files in Helena, Montana. These reports were first arranged by Avenues and Streets and then cross referenced by intersection. On-system sites were discarded in the process. The reports were then screened for locations having 5 or more accidents during the reporting period. The remaining accidents were entered into a computer program to calculate preliminary hazard index values.

Number of accidents, accident rates and severity indexes were calculated for fifty two cluster sites. Table 2 is a summary of the screening program. The cluster sites were ranked according to the composite value of the three indexes. A recommended list of sites was sent to Mike Wyatt, Technical Operations Supervisor, City of Great Falls, for his review and approval. The list was modified due to current and local knowledge of projects in progress and projects that had recently been completed. After undesirable sites had been eliminated, the final list of sites was approved.

**TABLE 2. CITY OF GREAT FALLS - ACCIDENT SITE SCREENING LIST
RANKING BY COMPOSITE ACCIDENT FACTOR**

SITE			TOTAL				NO.				ACC.		COMPOSITE
RANK		INTERSECTING	ACCIDENTS / YEAR				NO.	ACC.	APPROX.	ACC.	RATE	SVRTY	SCREEN
NO.	AVENUE or STREET	STREET OR AVENUE	88	89	90	91	ACC.	INDEX	VOLUME	RATE	INDEX	INDEX	INDEX
1	ELEVENTH AVE S	19TH STREET S	3	5	4	1	13	74	2200	5.11	83	50	69.5
2	FIFTH AVENUE S	13TH STREET S	3	3	2	0	8	81	1900	3.64	66	54	60.6
3	FIFTH AVENUE N	11TH STREET N	1	2	3	0	8	54	1200	4.33	74	48	60.0
4	SEVENTH AVE S	13TH STREET S	0	3	4	0	7	58	1600	3.78	68	52	59.8
5	FIFTH AVENUE S	23RD STREET S	0	1	8	0	7	58	1100	5.51	87	28	59.5
6	SECOND AVENUE S	23RD STREET S	4	3	0	0	7	58	1700	3.56	65	52	58.5
7	SECOND AVENUE S	2ND STREET S	1	3	11	1	16	79	7000	1.98	41	45	52.9
8	THIRD AVENUE S	8TH STREET S	2	2	2	0	8	54	1700	3.05	58	40	51.0
9	FIRST AVENUE S	PARK DRIVE	6	9	1	0	16	79	9000	1.54	34	47	50.9
10	ELEVENTH AVE S	26TH STREET S	4	8	2	0	14	78	6600	1.84	39	43	50.4
11	SECOND AVENUE S	9TH STREET S	6	3	7	2	16	82	13000	1.20	27	48	49.6
12	CENTRAL AVENUE	9TH STREET S	5	7	10	2	24	90	14000	1.48	33	35	49.4
13	FIRST AVENUE S	8TH STREET S	1	1	5	2	9	64	6200	1.26	28	56	47.5
14	CENTRAL AVENUE	4TH STREET S	5	2	7	0	14	78	8300	1.46	32	40	47.0
15	NINTH AVENUE S	13TH STREET S	1	4	2	0	7	58	2700	2.24	48	39	46.8
16	NINTH AVENUE S	9TH STREET S	4	5	4	2	15	78	10200	1.27	29	42	46.8
17	EIGHT AVENUE S	7TH STREET S	2	1	3	0	6	54	2900	1.79	38	48	45.9
18	EIGHT AVENUE S	10TH STREET S	2	0	3	1	6	54	2900	1.79	38	48	45.9
19	CENTRAL AVENUE	7TH STREET S	4	4	6	0	16	79	11000	1.26	28	38	45.8
20	ELEVENTH AVE S	29TH STREET S	1	2	6	0	9	64	5000	1.56	34	43	45.4
21	THIRD AVENUE N	4TH STREET N	2	1	4	0	7	58	3000	2.02	42	39	45.4
22	THIRTEENTH AVE S	9TH STREET S	3	4	4	0	11	69	6300	1.51	33	38	44.1
23	EIGHT AVENUE S	9TH STREET S	3	4	3	0	10	67	10500	0.82	20	51	43.2
24	FIFTH AVENUE S	7TH STREET S	0	3	3	0	6	54	2200	2.36	47	28	43.0
25	SECOND AVENUE S	4TH STREET S	1	3	3	2	9	64	5300	1.47	32	37	42.6
26	SECOND AVENUE S	3RD STREET S	3	2	1	0	6	54	5000	1.04	24	54	42.5
27	SIXTEENTH AVE NW	5 - 6TH ST NW	0	2	3	0	5	50	3300	1.31	29	51	42.2
28	CENTRAL AVENUE	2ND STREET S	3	5	3	0	11	69	7800	1.22	28	36	42.0
29	CENTRAL AVENUE	6TH STREET S	4	4	1	1	10	67	8700	0.99	23	42	41.7
30	THIRD AVENUE N	9TH STREET N	2	3	3	0	8	61	6100	0.85	20	50	41.5
31	24TH STREET S	10TH to 11TH	2	1	2	1	8	54	2500	2.08	43	28	41.3
32	ELEVENTH AVE S	33RD STREET S	4	2	0	0	6	54	5900	0.88	21	54	41.2
33	ELEVENTH AVE S	24TH STREET S	3	2	1	0	6	54	3500	1.48	33	40	41.2
34	CENTRAL AVENUE	3RD STREET S	1	3	4	0	8	81	7800	0.89	21	45	40.1
35	THIRD AVENUE S	46TH STREET S	1	4	2	0	7	58	3500	1.73	37	28	40.0
36	FIRST AVENUE S	3RD STREET S	1	1	5	0	7	58	6700	0.90	21	46	39.6
37	NINTH STREET S	9TH to 10TH	1	4	2	0	7	58	9700	0.62	16	52	39.4
38	9TH STREET N	BRIDGE APPROACH	1	0	2	3	6	54	6000	0.87	21	48	39.1
39	DIVISION ROAD	RIVERVIEW, 1 to D	2	4	5	0	11	69	4300	1.11	26	28	38.7
40	CENTRAL AVENUE	10TH STREET S	1	5	2	0	6	61	8800	0.79	19	43	38.6
41	SECOND AVENUE S	13TH STREET S	1	2	1	2	6	54	4700	1.10	25	40	38.4
42	FIRST AVENUE S	2ND STREET S	1	4	1	1	7	58	9000	0.67	17	48	37.9
43	FIRST AVENUE S	13TH STREET S	2	3	1	0	6	54	3400	1.53	33	28	37.6
44	THIRTEENTH AVE S	14TH STREET S	2	2	2	0	6	54	5300	0.98	23	40	37.5
45	SECOND AVENUE S	8TH STREET S	1	2	4	0	7	58	5500	1.10	25	28	36.5
46	FIFTH AVENUE N	9TH STREET N	2	0	3	1	6	54	7600	0.68	17	40	36.1
47	SIXTH AVENUE N	9TH STREET N	0	3	3	0	6	54	7800	0.68	17	40	36.1
48	FIRST AVENUE S	10TH STREET S	1	4	1	0	6	54	4600	1.13	26	28	34.7
49	SECOND AVENUE S	7TH STREET S	2	2	2	1	7	58	8100	0.99	23	28	34.7
50	CENTRAL AVENUE	13TH STREET S	2	0	4	0	6	54	6700	0.60	15	40	34.3
51	FIRST AVENUE S	9TH STREET S	0	0	3	2	5	50	13200	0.33	9	51	34.2
TOTALS =			107	147	168	25	447						
AVE. YEAR =			2.1	2.9	3.3	0.5	8.6	81.7	5976.5	1.7	34.0	42.1	44.4

NOTE: 1991 Accidents only include the months of January and February.

Phase 2, Data Collection - included preliminary organization of the project including scheduling, site location, form processing, field data collection and reduction of data. Accident data was obtained from reports provided by the Department of Justice. Traffic counts were taken at each location. The existing average daily traffic was determined by applying factors for hourly, daily and monthly variations. Historical traffic volumes were provided by Montana Department of Highways. Other data collected in the field, included measurement of road widths and geometrics, and inventory of traffic control devices, turning movement counts and subjective observation of traffic operations. Neil Consultants of Great Falls performed the field topo surveys, sign inventories and base sheet drafting.

Phase 3, Analysis of Data - included the determination of hazard indexes for each location by using the Federal Highway Administration Report *No. FHWA-RD-77-83 "Identification of Hazardous Locations"*. Computations involved with accidents, volumes, capacities, indicator values and other aspects of hazard indexes were performed on a microcomputer using original templates for Ouattro Pro Ver. 3.0, developed by Marvin & Associates. Regression equations were developed to mathematically simulate hazard index curves contained in the FHA report. From these computations a preliminary hazard ranking list was prepared.

Phase 4, Evaluation of Corrective Measures - included the determination of improvements that would reduce or eliminate certain types of accidents or accidents in general at the study locations. Preliminary designs of those improvements included signing, geometric changes, and some minor reconstruction. The improvements were recommended on a short term basis. In most cases, the nature of the sites was such that long term improvements could not be recommended.

Cost effectiveness calculations of the improvements at each location were determined by preparing preliminary cost estimates and computing economic benefits to arrive at a benefit/cost ratio. The method used to determine benefit/cost ratios is identical to that used by the Montana Department of Transportation Project Planning Section. All values used in the formulation were supplied by Hank Butzlaff, supervisor of that section. The composite hazard index ranking and benefit/cost ratio, then determined the final priority listing.

HAZARD INDEX ANALYSIS RESULTS

Seven hazard indexes were used as the preliminary basis of ranking hazardous sites. The following are brief descriptions of each index including data format, data collection, indicator scaling and site ranking with respect to each index.

1. Number of Accidents - This indicator provides a historical background of accidents at the investigation site. In the case of Great Falls, a three year, two month period was used, which included 1988 - February 1991. The accident reports were photo copied in Helena and provided to the consultant. The data represents all reports filed within the city limits of Great Falls.

Figure 3. is a curve extracted from the FHWA report which was used to determine the indicator value. The data base is number of accidents per year. This indicator, as all of the seven indicators used in the report, is scaled between 0 and 100. An average of two accidents per year in a three year period indicates a hazardous location (indicator value of 33). Ten accidents on the average per year is used to designate a very hazardous location (indicator value of 67). In the case of this study, the total accidents number of accidents per site criteria was used to extract the index value rather than the annual rate. This higher value is therefore more consistent with the level of the other index values. Using an annual rate would have scaled down the importance of this indicator relative to other index values. Table 3. is the computer generated ranking of all sites based on this indicator. It can be seen that none of the sites exceeded the maximum value of 100 and the average value was in the same range as other hazard index values.

2. Accident Rate Indicator - This indicator somewhat compensates for any incomplete information provided by the number of accident indicator in that an exposure value is provided by the relationship between accidents and the total volume of vehicles using the facility. The data base for this indicator is expressed as the number of accidents per million entering vehicles. In the case of an intersection, "million entering vehicles" is the sum of the daily average approach volumes on all legs of the intersection, multiplied by the number of days in the analysis period.

TABLE 3. SITE RANKING BY NUMBER OF ACCIDENTS

RANK NO.	AVENUE	STREET	ACCIDENTS / YEAR				TOTAL NO. ACC.	NO. ACC. INDEX
			88	89	90	91		
1	CENTRAL AVENUE	9TH STREET S	5	7	10	2	24	90
2	SECOND AVENUE S	9TH STREET S	6	3	7	2	18	82
3	CENTRAL AVENUE	7TH STREET S	3	4	9	0	16	79
4	NINTH AVENUE S	9TH STREET S	4	5	4	2	15	78
5	SECOND AVENUE S	2ND STREET S	1	4	9	1	15	78
6	ELEVENTH AVE S	26TH STREET S	4	8	2	0	14	76
7	CENTRAL AVENUE	4TH STREET S	5	1	6	0	12	72
8	FIRST AVENUE S	PARK DRIVE	5	6	1	0	12	72
9	THIRTEENTH AVE S	9TH STREET S	3	4	4	0	11	69
10	EIGHT AVENUE S	9TH STREET S	3	4	3	0	10	67
11	ELEVENTH AVE S	29TH STREET S	1	2	6	0	9	64
12	SECOND AVENUE S	4TH STREET S	1	3	3	2	9	64
13	FIRST AVENUE S	8TH STREET S	1	1	4	2	8	61
14	FIFTH AVENUE S	23RD STREET S	0	1	6	0	7	58
15	FIFTH AVENUE S	13TH STREET S	3	2	2	0	7	58
16	SECOND AVENUE S	23RD STREET S	4	3	0	0	7	58
17	SEVENTH AVE S	13TH STREET S	0	3	4	0	7	58
18	THIRD AVENUE S	46TH STREET S	1	4	2	0	7	58
19	EIGHT AVENUE S	7TH STREET S	2	1	3	0	6	54
20	EIGHT AVENUE S	10TH STREET S	2	0	3	1	6	54
21	FIFTH AVENUE N	11TH STREET N	1	2	3	0	6	54
22	FIFTH AVENUE S	7TH STREET S	0	3	3	0	6	54
23	THIRD AVENUE N	4TH STREET N	2	1	3	0	6	54
24	SIXTEENTH AVE NW	5 - 6TH ST NW	0	2	3	0	5	50
25	THIRD AVENUE S	8TH STREET S	2	1	2	0	5	50
TOTALS =			59	75	102	12	248	
AVERAGES =			2.4	3.0	4.1	0.5	9.9	64.4

NOTE: 1991 DATA ONLY INCLUDES JANUARY AND FEBRUARY

The accident rate indicator is a very important part of the hazard index ranking method and data collection is possible when a continued program of traffic counting has been performed. Spot counts adjusted by yearly volume increases, seasonal variations, daily variations and hourly variations were necessary at most of the sites to develop an average daily traffic figure applied to the analysis period.

Figure 4 represents the graphic plot of accident rate versus indicator value. As before, the indicator value ranges between 0 and 100. Table 4 is the computer generated ranking of sites based on this indicator. It can be seen that the intersections included in this study were not major high volume locations in Great Falls, since the average rate index was below 50.

3. Accident Severity Indicator - Although there are many factors involved in the severity of accidents, statistical studies over a significant number of years have given fairly reliable dollar values in terms of economic loss for each type of accident. The accident severity indicator correlates a probable cause and effect relationship which aids in the determination of the level of accident reduction measures required. Severity values can also be used as a determinant of benefits resulting from various improvements. The data base for accident severity is average relative severity in thousands of dollars. Data collection necessary for the use of the severity index is made possible by the accident report form. Dollar values for severity were provided by Hank Butzlaff of the Montana Department of Transportation. They are: Fatal Accident = \$500,000, Injury Accident = \$11,000 and Property Damage Accident = \$2,000. Recently, the method of calculating fatal and injury costs was changed by MDoT to include total number of persons injured or killed rather than just an injury or fatal accident as a single incident. In one study case, a single accident produced 5 injuries which increased the relative severity of that site significantly.

The FHWA report presents the relative severity index values for each type of accident. Once the type of accident has been established, Figure 5 enables the user to assess the indicator value. Figure 5 is a graphic plot of the average severity in thousands of dollars versus the indicator value which is based on a scale of 0 to 100. Table 5 is the computer generated ranking of sites based on this indicator.

TABLE 4. SITE RANKING BY ACCIDENT RATE

RANK NO.	AVENUE	STREET	NO. ACC.	1991 ADT	ADT	ACC.	ACC RATE IND VALUE
			3.16 YEARS		PERIOD AVE.	RATE (MVE)	
1	EIGHT AVENUE S	7TH STREET S	6	1471	1400	3.71	67
2	FIFTH AVENUE N	11TH STREET N	6	1469	1400	3.71	67
3	FIFTH AVENUE S	23RD STREET S	7	1868	1800	3.36	62
4	SEVENTH AVE S	13TH STREET S	7	1829	1850	3.27	61
5	SECOND AVENUE S	23RD STREET S	7	1982	1900	3.19	60
6	THIRD AVENUE S	8TH STREET S	5	1557	1500	2.88	55
7	FIFTH AVENUE S	13TH STREET S	7	2634	2300	2.63	52
8	EIGHT AVENUE S	10TH STREET S	6	1650	2000	2.60	51
9	SIXTEENTH AVE NW	5 - 6TH ST NW	5	1876	1800	2.40	48
10	FIFTH AVENUE S	7TH STREET S	6	2923	2700	1.92	40
11	CENTRAL AVENUE	7TH STREET S	16	8280	7900	1.75	37
12	ELEVENTH AVE S	26TH STREET S	14	7625	7100	1.71	37
13	THIRD AVENUE N	4TH STREET N	6	3600	3300	1.57	34
14	SECOND AVENUE S	4TH STREET S	9	5560	5100	1.53	33
15	CENTRAL AVENUE	9TH STREET S	24	14472	14350	1.45	32
16	THIRTEENTH AVE S	9TH STREET S	11	7515	6900	1.38	31
17	SECOND AVENUE S	2ND STREET S	15	10146	10000	1.30	29
18	THIRD AVENUE S	46TH STREET S	7	4506	4700	1.29	29
19	CENTRAL AVENUE	4TH STREET S	12	8157	8200	1.27	29
20	FIRST AVENUE S	8TH STREET S	8	7088	5500	1.26	28
21	ELEVENTH AVE S	29TH STREET S	9	8698	6800	1.14	26
22	FIRST AVENUE S	PARK DRIVE	12	9517	9900	1.05	24
23	SECOND AVENUE S	9TH STREET S	18	14466	15000	1.04	24
24	NINTH AVENUE S	9TH STREET S	15	14943	12600	1.03	24
25	EIGHT AVENUE S	9TH STREET S	10	13448	12000	0.72	18
AVERAGE VALUES			10	6291	5920	1.97	40

TABLE 5. SITE RANKING BY ACCIDENT SEVERITY

RANK NO.	AVENUES	STREETS	SUM OF SEVERITY VALUES	TOTAL NO. ACC.	AVERAGE SEVERITY INDEX	INDICATOR VALUE
1	EIGHT AVENUE S	10TH STREET S	\$85,000	6	\$14,167	74
2	FIRST AVENUE S	8TH STREET S	\$94,000	8	\$11,750	69
3	SEVENTH AVE S	13TH STREET S	\$74,000	7	\$10,571	66
4	FIFTH AVENUE S	13TH STREET S	\$59,000	7	\$8,429	60
5	SECOND AVENUE S	23RD STREET S	\$41,000	7	\$5,857	52
6	SECOND AVENUE S	9TH STREET S	\$101,000	18	\$5,611	51
7	EIGHT AVENUE S	9TH STREET S	\$56,000	10	\$5,600	51
8	SIXTEENTH AVE NW	5 - 6TH ST NW	\$28,000	5	\$5,600	51
9	EIGHT AVENUE S	7TH STREET S	\$30,000	6	\$5,000	49
10	FIFTH AVENUE N	11TH STREET N	\$30,000	6	\$5,000	49
11	ELEVENTH AVE S	26TH STREET S	\$68,000	14	\$4,857	49
12	NINTH AVENUE S	9TH STREET S	\$70,000	15	\$4,667	48
13	CENTRAL AVENUE	7TH STREET S	\$72,000	16	\$4,500	47
14	SECOND AVENUE S	2ND STREET S	\$66,000	15	\$4,400	47
15	ELEVENTH AVE S	29TH STREET S	\$38,000	9	\$4,222	46
16	THIRD AVENUE S	8TH STREET S	\$19,000	5	\$3,800	44
17	CENTRAL AVENUE	9TH STREET S	\$88,000	24	\$3,667	43
18	CENTRAL AVENUE	4TH STREET S	\$42,000	12	\$3,500	43
19	THIRD AVENUE N	4TH STREET N	\$21,000	6	\$3,500	43
20	SECOND AVENUE S	4TH STREET S	\$27,000	9	\$3,000	40
21	THIRTEENTH AVE S	9TH STREET S	\$31,000	11	\$2,818	39
22	FIRST AVENUE S	PARK DRIVE	\$33,000	12	\$2,750	39
23	FIFTH AVENUE S	7TH STREET S	\$12,000	6	\$2,000	34
24	FIFTH AVENUE S	23RD STREET S	\$14,000	7	\$2,000	34
25	THIRD AVENUE S	46TH STREET S	\$14,000	7	\$2,000	34
TOTAL SEVERITY \$ = \$1,213,000						
TOTAL NO. ACC. =				248		
AVE. SEVERITY / ACC. =					\$4,891	
AVE. IND. VAL / SITE =						48

4. Volume to Capacity Ratio Indicator - This indicator not only produces exposure rates but also incorporates existing street geometry, access and conditions such as traffic type, turning directions, volume mix and number of lanes. Computation of the volume capacity indicator is expressed as follows:

$$V/C = ADT/24 \text{ HOUR CAPACITY}$$

Modifications to the basic V/C formula were felt necessary because of the predominance of intersections within this study and the vast changes that have occurred in capacity theory since the time when the FHWA report was published. Use of the original formula would have diluted the relative importance of this indicator if calculated in this manner. Therefore, volume/capacity calculation using the 1985 Highway Capacity Manual procedures were used and expressed as a peak hour V/C. If the above formula were used, the maximum index value would have been 70 and half of the sites would have had an indicator value less than 10.

Data required for the volume capacity ratio involved field measurements of existing geometrics, turning counts and volume mix. The capacity of each intersection is computed through methodology presented in the 1985 *Highway Capacity Manual* using FHWA computer software. Although this indicator is cumbersome to use by inexperienced personnel, its inclusion is considered necessary and correlates well in hazardous index ranking.

Figure 6. presents a graphic plot of the volume capacity ratio versus the indicator value which is also scaled between 0 and 100. Table 6. is the computer generated ranking of the sites based on this indicator. The average value for this indicator was 46 while values ranged between 9 and 91.

TABLE 6. SITE RANKING BY VOLUME/CAPACITY

RANK			PEAK	PEAK	*	V/C
NO.	AVENUES	STREETS	HOUR	HOUR	V/C	INDICATOR
			CAPACI	FLOW	RATIO	VALUE
1	ELEVENTH AVE S	29TH STREET S	365	234	0.64	91
2	THIRTEENTH AVE S	9TH STREET S	552	351	0.64	91
3	SECOND AVENUE S	9TH STREET S	**	**	0.60	87
4	NINTH AVENUE S	9TH STREET S	172	98	0.57	84
5	EIGHT AVENUE S	9TH STREET S	254	144	0.57	84
6	ELEVENTH AVE S	26TH STREET S	653	298	0.46	72
7	SIXTEENTH AVE NW	5 - 6TH ST NW	1409	496	0.35	60
8	THIRD AVENUE S	46TH STREET S	685	229	0.33	58
9	SECOND AVENUE S	2ND STREET S	**	**	0.30	54
10	FIRST AVENUE S	PARK DRIVE	2062	571	0.28	51
11	CENTRAL AVENUE	9TH STREET S	**	**	0.27	50
12	FIRST AVENUE S	8TH STREET S	575	156	0.27	50
13	CENTRAL AVENUE	4TH STREET S	**	**	0.23	45
14	CENTRAL AVENUE	7TH STREET S	**	**	0.23	45
15	SECOND AVENUE S	4TH STREET S	550	123	0.22	44
16	THIRD AVENUE N	4TH STREET N	925	116	0.13	29
17	FIFTH AVENUE S	7TH STREET S	794	77	0.10	25
18	SECOND AVENUE S	23RD STREET S	960	90	0.09	24
19	FIFTH AVENUE N	11TH STREET N	905	81	0.09	23
20	FIFTH AVENUE S	13TH STREET S	940	65	0.07	19
21	THIRD AVENUE S	8TH STREET S	954	58	0.06	18
22	EIGHT AVENUE S	10TH STREET S	922	39	0.04	14
23	FIFTH AVENUE S	23RD STREET S	943	33	0.03	12
24	EIGHT AVENUE S	7TH STREET S	949	28	0.03	11
25	SEVENTH AVE S	13TH STREET S	887	22	0.02	9
AVERAGE VALUES			658	132	0	46

* V/C Refers to capacity of the minor street in the case of uncontrolled or stop/yield controlled intersections.

** V/C Refers to average v/c for all legs of signalized intersection.

5. Sight Distance Indicator - This indicator is of significant value in both rural and urban locations, especially at intersections. Even though the weighting factor in the hazard index computation is low, it is still considered valuable in determining cause and effect relationships and other deficiencies at the accident cluster sites.

The data format for using the sight distance indicator is the ratio of actual sight distance to desirable sight distance. The FHWA report presents the minimum stopping sight distance on wet pavement for the various design speeds. Actual stopping sight distance is the distance from the drivers position to the point where a stop may be required to avoid a hazardous maneuver or direct collision. Required sight distances vary according to the type of control encountered. At uncontrolled intersections specific AASHTO guidelines for this situation are used. At stop controlled and signalized intersections two different requirements are applied: 1. stopping sight distance to the control device & 2. intersection sight distance required to cross the intersection. The various required sight distances and measured values are computed and combined according to the study method's formulation to determine the indicator value.

The data format for this indicator is the sight distance ratio of actual over desirable. Collection of the sight distance data requires field measurements of sight distance and determination of average travel speeds. Figure 7. presents a graphic plot of the sight distance ratio versus the indicator value which ranges from 0 to 100. Table 7. is the computer generated ranking of sites based on this indicator. A total of 9 sites had indicator values of 100 and they ranged down to 21. Considering all of the possible restrictions present in an urban environment, the higher values should not be unexpected.

TABLE 7. SITE RANKING BY SIGHT DISTANCE

RANK NO.	INTERSECTION LOCATION		APP1 REQ			APP2 REQ			APP3 REQ			APP4 REQ			*WT. IND VAL
			SD	SD	RATIO	SD	SD	RATIO	SD	SD	RATIO	SD	SD	RATIO	
1	NINTH AVENUE S	9TH STREET S	15	200	0.08	15	200	0.08	140	350	0.40	120	350	0.34	100
2	SECOND AVENUE S	4TH STREET S	75	200	0.38	80	400	0.15	65	200	0.33	120	400	0.30	100
3	SIXTEENTH AVE NW	5 - 6TH ST NW	300	200	1.50	70	300	0.23	70	200	0.35	100	300	0.33	100
4	FIRST AVENUE S	8TH STREET S	80	200	0.40	75	300	0.25	160	200	0.80	100	300	0.33	100
5	EIGHT AVENUE S	9TH STREET S	110	380	0.31	70	200	0.35	100	350	0.29	80	200	0.40	100
6	THIRD AVENUE S	46TH STREET S	50	200	0.25	120	300	0.40	300	200	1.50	120	300	0.40	100
7	ELEVENTH AVE S	29TH STREET S	90	200	0.45	115	380	0.33	160	200	0.80	100	350	0.29	100
8	THIRTEENTH AVE S	9TH STREET S	180	400	0.40	110	200	0.55	130	400	0.33	80	200	0.40	100
9	ELEVENTH AVE S	26TH STREET S	180	275	0.65	180	300	0.80	140	275	0.51	120	300	0.40	100
10	FIRST AVENUE S	PARK DRIVE	110	400	0.28	300	275	1.09	300	275	1.09			ERR	97
11	EIGHT AVENUE S	7TH STREET S	70	110	0.64	70	110	0.64	80	110	0.73	110	110	1.00	78
12	FIFTH AVENUE S	7TH STREET S	80	110	0.73	75	110	0.68	70	110	0.64	80	110	0.73	75
13	THIRD AVENUE N	4TH STREET N	75	110	0.68	75	110	0.68	80	110	0.73	75	110	0.68	71
14	FIFTH AVENUE N	11TH STREET N	80	110	0.73	80	110	0.73	80	110	0.73	75	110	0.68	68
15	EIGHT AVENUE S	10TH STREET S	80	110	0.73	150	110	1.36	75	110	0.68	115	110	1.05	68
16	THIRD AVENUE S	8TH STREET S	100	110	0.91	110	110	1.00	75	110	0.68	110	110	1.00	59
17	SECOND AVENUE S	23RD STREET S	130	110	1.18	70	110	0.64	110	110	1.00	110	110	1.00	59
18	CENTRAL AVENUE	4TH STREET S	140	200	0.70	190	200	0.95	240	200	1.20	190	200	0.95	56
19	SEVENTH AVE S	13TH STREET S	110	110	1.00	110	110	1.00	110	110	1.00	110	110	1.00	35
20	FIFTH AVENUE S	23RD STREET S	140	110	1.27	140	110	1.27	100	110	0.91	140	110	1.27	32
21	CENTRAL AVENUE	7TH STREET S	230	200	1.15	240	200	1.20	230	200	1.15	210	200	1.05	29
22	SECOND AVENUE S	9TH STREET S	300	275	1.09	300	275	1.09	300	275	1.09			ERR	28
23	CENTRAL AVENUE	9TH STREET S	300	275	1.09	300	275	1.09	600	275	2.18	600	275	2.18	28
24	FIFTH AVENUE S	13TH STREET S	150	110	1.38	180	110	1.64	180	110	1.36	120	110	1.09	23
25	SECOND AVENUE S	2ND STREET S	400	275	1.45	400	275	1.45	300	275	1.09			ERR	21
AVERAGE INDICATOR VAL															69.0

* WEIGHTED INDICATOR VALUE IS CALCULATED BY THE FORMULA (2nd-HIGHVAL + 2nd-HIGHVAL)/3

APP# SD's = MEASURED SIGHT DISTANCE ON DIRECTIONAL APPROACHES FOR VARIOUS CONDITIONS OF CONTROL

REQ SD = REQUIRED SIGHT DISTANCE ACCORDING TO AASHO

6. Driver Expectancy Indicator - This indicator relates human behavior factors to existing road conditions. The value of this indicator is realized in the fact that the roadway geometrics and roadside culture are evaluated on a human judgement basis.

The data format for the driver expectancy index is the problem rating scale. Being a subjective indicator, the degree of expectancy is rated on a scale from 1 to 6, and the expectancy rating varies linearly with the indicator value as shown in Figure 8. The expectancy rating form can be found in the FHWA report for further reference. Table 8. is the computer generated ranking of sites based on this indicator.

7. Information System Deficiencies Indicator - This indicator also provides a value or subjective judgement on the sufficiency of traffic control devices which transfer necessary information to the operator.

The data format for the information system deficiencies indicator is similar to that of the driver expectancy indicator in that a value form is used to provide a rating between 1 and 6. The rating for this indicator is also plotted linearly between the indicator range values of 0 and 100 and is shown on Figure 9. The value rating form is for the information system deficiencies indicator. It is also presented in the FHWA report for further reference. Table 9. is the computer generated ranking of sites based on this indicator.

TABLE 8. SITE RANKING BY DRIVER EXPECTANCY

RANK			NB	SB	EB	WB	WGTD.	IND
NO.	AVENUE	STREET	RATE	RATE	RATE	RATE	RATE	VAL
1	THIRTEENTH AVE S	9TH STREET S	6	6	6	6	6.0	100
2	ELEVENTH AVE S	29TH STREET S	6	6	6	6	6.0	100
3	SEVENTH AVE S	13TH STREET S	6	6	6	6	6.0	100
4	FIFTH AVENUE S	13TH STREET S	6	4	5	6	5.3	88
5	EIGHT AVENUE S	9TH STREET S	5	4	5	5	4.8	79
6	FIFTH AVENUE S	23RD STREET S	5	5	4	4	4.5	75
7	FIRST AVENUE S	PARK DRIVE		3	5	5	4.3	72
8	NINTH AVENUE S	9TH STREET S	5	4	4	4	4.3	71
9	CENTRAL AVENUE	4TH STREET S	5	5	3	3	4.0	67
10	CENTRAL AVENUE	7TH STREET S	5	5	3	3	4.0	67
11	EIGHT AVENUE S	7TH STREET S	4	4	4	4	4.0	67
12	FIRST AVENUE S	8TH STREET S	5	4		3	4.0	67
13	SECOND AVENUE S	23RD STREET S	5	3	3	5	4.0	67
14	THIRD AVENUE S	8TH STREET S	4	3	5	4	4.0	67
15	FIFTH AVENUE N	11TH STREET N	3	3	5	5	4.0	67
16	SECOND AVENUE S	9TH STREET S	5	4		3	4.0	67
17	SIXTEENTH AVE NW	5 - 6TH ST NW	2	4	6	3	3.8	63
18	THIRD AVENUE N	4TH STREET N	3	3	4	4	3.5	58
19	ELEVENTH AVE S	26TH STREET S	3	3	4	4	3.5	58
20	CENTRAL AVENUE	9TH STREET S	3	3	4	4	3.5	58
21	SECOND AVENUE S	2ND STREET S	2	2	6		3.3	56
22	THIRD AVENUE S	46TH STREET S	2	3	3	5	3.3	54
23	SECOND AVENUE S	4TH STREET S	2	3	4		3.0	50
24	EIGHT AVENUE S	10TH STREET S	3	4	2	2	2.8	46
25	FIFTH AVENUE S	7TH STREET S	2	2	2	2	2.0	33
AVERAGE INDICATOR VALUE =								67.8

TABLE 9. SITE RANKING BY INFORMATION DEFICIENCY

RANK NO.	AVENUES	STREETS	NB RATE	SB RATE	EB RATE	WB RATE	WGTD. RATE	IND VAL
1	FIFTH AVENUE S	23RD STREET S	4	5	6	5	5.0	83
2	SECOND AVENUE S	2ND STREET S	4	5	6		5.0	83
3	ELEVENTH AVE S	29TH STREET S	5	5	5	5	5.0	83
4	FIRST AVENUE S	PARK DRIVE		4	5	5	4.7	78
5	THIRTEENTH AVE S	9TH STREET S	5	5	4	4	4.5	75
6	CENTRAL AVENUE	7TH STREET S	5	5	4	4	4.5	75
7	CENTRAL AVENUE	4TH STREET S	5	5	4	4	4.5	75
8	SEVENTH AVE S	13TH STREET S	3	3	6	6	4.5	75
9	FIFTH AVENUE S	13TH STREET S	6	6	3	3	4.5	75
10	SECOND AVENUE S	4TH STREET S	4	5	4		4.3	72
11	NINTH AVENUE S	9TH STREET S	4	4	4	4	4.0	67
12	EIGHT AVENUE S	9TH STREET S	4	4	4	4	4.0	67
13	THIRD AVENUE N	4TH STREET N	3	3	5	5	4.0	67
14	THIRD AVENUE S	8TH STREET S	4	3	5	4	4.0	67
15	CENTRAL AVENUE	9TH STREET S	3	3	4	5	3.8	63
16	SECOND AVENUE S	9TH STREET S	3	2	5		3.3	56
17	THIRD AVENUE S	46TH STREET S	2	3	4	4	3.3	54
18	ELEVENTH AVE S	26TH STREET S	2	3	4	4	3.3	54
19	SIXTEENTH AVE NW	5 - 6TH ST NW	2	4	3	3	3.0	50
20	EIGHT AVENUE S	7TH STREET S	3	3	3	3	3.0	50
21	EIGHT AVENUE S	10TH STREET S	3	3	3	3	3.0	50
22	FIFTH AVENUE N	11TH STREET N	3	3	3	3	3.0	50
23	SECOND AVENUE S	23RD STREET S	3	2	3	3	2.8	46
24	FIFTH AVENUE S	7TH STREET S	2	4	2	2	2.5	42
25	FIRST AVENUE S	8TH STREET S	2	2		2	2.0	33
AVERAGE INDICATOR VALUE =								63.6

HAZARD RANKING

Once all of the data had been collected and the indicator values computed, indicator values and necessary data were transferred to the hazard index computation matrix. Each indicator is weighted in accordance with the FHWA report. The weighting factors are fractional portions of unity. When all nine indicators established in FHWA report are used, the sum of weights is equal to one. In the case of Great Falls, two indicators were omitted, the Traffic Conflict Indicator and the Erratic Maneuvers Indicator. Their exclusion from the study was not felt to be any deterrent in the ranking of hazardous sites. The use of seven indicators provides an 88.6% confidence in strength of evaluation.

Based on the hazard analysis for each site, a matrix of indicator values and final hazard index ratings was constructed on a Quattro Pro template and a hazard index ranking was completed. Table 10., on the following page, lists this ranking by site number, location, indicator values and hazard index. Also shown is statistical information for the indicator values and hazard index.

During the process of field data collection and subsequent indicator computations, it was discovered that values for the two subjective indicators could vary widely between consecutive observations and among non-experienced observers. If Great Falls should choose to duplicate these efforts in the future and continue this program, staff traffic personnel should be chosen who will continue to update the high hazard priority list on a long term basis and therefore, these indicators should remain as part of the hazard index ranking as long as consistency can be maintained.

TABLE 10. SITE RANKING BY HAZARD INDEX - SUMMARY OF INDICATOR VALUES

			# OF ACC.		ACC. RATE		SEVERITY		V/C RATIO		SIGHT DIST		EXPECT.		INFO DEF.		TOTAL
			IND	PART	IND	PART	IND	PART	IND	PART	IND	PART	IND	PART	IND	PART	HAZARD
			VAL	H.I.	VAL	H.I.	VAL	H.I.	VAL	H.I.	VAL	H.I.	VAL	H.I.	VAL	H.I.	INDEX
RANK			Wgt.		Wgt.		Wgt.		Wgt.		Wgt.		Wgt.		Wgt.		Wgt.
NO.			16.4%		22.5%		19.1%		6.2%		7.4%		14.9%		11.5%		100%
1	ELEVENTH AVE S	29TH STREET S	64	10.4	26	5.8	48	6.7	91	7.5	100	7.4	100	14.8	63	9.5	64.2
2	THIRTEENTH AVE S	9TH STREET S	89	11.2	31	6.9	39	7.4	91	7.5	100	7.4	100	14.8	75	8.8	63.9
3	SEVENTH AVE S	13TH STREET S	58	9.5	81	13.7	66	12.5	9	0.7	35	2.6	100	14.8	75	6.8	62.4
4	NINTH AVENUE S	9TH STREET S	78	12.7	24	5.4	48	9.1	84	6.9	100	7.4	71	10.5	87	7.7	59.7
5	EIGHT AVENUE S	9TH STREET S	67	10.9	18	4.0	51	9.7	84	6.9	100	7.4	79	11.7	87	7.7	58.3
6	ELEVENTH AVE S	26TH STREET S	78	12.4	37	6.3	49	9.3	72	5.9	100	7.4	58	6.8	54	6.2	58.1
7	FIFTH AVENUE S	13TH STREET S	58	9.5	52	11.8	60	11.4	19	1.8	23	1.7	88	13.0	75	8.6	57.4
8	SIXTEENTH AVE NW	5 - 8TH ST NW	50	6.2	48	10.8	51	9.7	60	4.9	100	7.4	63	9.3	50	5.8	56.0
9	FIFTH AVENUE N	11TH STREET N	54	6.8	87	15.0	49	9.3	23	1.9	68	5.0	67	9.9	50	5.8	55.7
10	FIRST AVENUE S	PARK DRIVE	72	11.7	24	5.4	39	7.4	51	4.2	97	7.2	72	10.7	78	9.0	55.5
11	EIGHT AVENUE S	7TH STREET S	54	6.8	87	15.0	49	9.3	11	0.9	78	5.8	87	9.9	50	5.8	55.5
12	FIRST AVENUE S	8TH STREET S	81	9.9	28	6.3	69	13.1	50	4.1	100	7.4	67	9.9	33	3.8	54.5
13	CENTRAL AVENUE	7TH STREET S	79	12.9	37	6.3	47	6.9	45	3.7	29	2.1	87	9.9	75	6.8	54.5
14	SECOND AVENUE S	23RD STREET S	58	9.5	60	13.4	52	9.9	24	2.0	59	4.4	67	9.9	46	5.3	54.3
15	SECOND AVENUE S	9TH STREET S	82	13.4	24	5.4	51	9.7	87	7.1	28	2.1	67	9.9	56	6.4	54.0
16	FIFTH AVENUE S	23RD STREET S	58	9.5	82	13.9	34	6.5	12	1.0	32	2.4	75	11.1	83	9.5	53.8
17	EIGHT AVENUE S	10TH STREET S	54	6.8	51	11.4	74	14.1	14	1.1	68	5.0	46	6.8	50	5.8	53.0
18	CENTRAL AVENUE	4TH STREET S	72	11.7	29	6.5	43	8.2	45	3.7	56	4.1	67	9.9	75	8.8	52.8
19	THIRD AVENUE S	8TH STREET S	50	6.2	55	12.3	44	6.4	18	1.5	59	4.4	87	9.9	87	7.7	52.3
20	SECOND AVENUE S	4TH STREET S	64	10.4	33	7.4	40	7.6	44	3.6	100	7.4	50	7.4	72	8.3	52.1
21	CENTRAL AVENUE	9TH STREET S	90	14.7	32	7.2	43	6.2	50	4.1	28	2.1	58	8.6	63	7.2	52.0
22	SECOND AVENUE S	2ND STREET S	78	12.7	29	6.5	47	6.9	54	4.4	21	1.6	56	8.3	83	9.5	52.0
23	THIRD AVENUE S	46TH STREET S	58	9.5	29	6.5	34	6.5	58	4.8	100	7.4	54	8.0	54	6.2	48.8
24	THIRD AVENUE N	4TH STREET N	54	6.8	34	7.6	43	8.2	29	2.4	71	5.3	58	8.6	87	7.7	48.5
25	FIFTH AVENUE S	7TH STREET S	54	6.8	40	9.0	34	6.5	25	2.1	75	5.6	33	4.9	42	4.6	41.5
AVERAGE VALUES =			64		40		48		46		69		68		64		55
STANDARD DEVIATIONS =			11		15		10		27		30		16		14		5

EXPLANATION OF IMPROVEMENTS

The recommended improvements presented within this report are short term improvements and reflect the minimum amount of upgrading or modifications necessary to increase driver expectancy and also update the site to current standards. Long term improvements are only considered viable when severe conditions at the site prevent short term improvements from completely satisfying the control measures necessary to prevent future problems. Since any long term improvements would be dependant upon significant changes in future traffic operations and most of the sites were not of a nature that reliable predictions could be made within the scope of this study, no specific plans were advanced and no costs or project ranking was completed for long term improvements. However, general recommendations of a long term nature are made within the site specific section when applicable.

Many of the recommended improvements have sufficient latitude so that alternative measures could be suggested during design. The selection of recommended improvements was based on subjective engineering judgement. Basis of the recommendations incorporate an understanding of driver psychology, visual input requirements, accident statistics and comparative studies. Some of the recommended improvements are not directly related to accident prevention, but are required to meet current standards and provide consistent control measures. Specific reasons for recommendations are presented in the site specific section of this report.

Recommendations for plastic pavement markings are replete throughout the study. Painted marks may be substituted to substantially reduce the City's cost. However, more intense maintenance will be needed if this alternative is chosen. If the marks are worn most of the time, they will not functioned as planned.

The improvement sketches, in some cases should not be considered design plans. Some of the more complex drawings are preliminary and are intended to present improvement concepts only in enough detail to provide the measure of control necessary and to provide cost estimates. In some cases, detailed survey data; design analysis; design plans and specifications; and construction layout will be necessary to effectively achieve the improvements.

BENEFIT/COST RATIOS

COSTS

Preliminary cost estimates are developed by applying unit costs to required quantities based either on current prices as tabulated from average bid prices of similar projects or, where applicable, on prices established by Montana Department of Transportation's Project Planning Section. The costs should in no way be considered a quote or final estimate of actual work.

The following are traffic control devices and allowable costs that are eligible for funding by the Montana Department of Highways through their Off-System Safety Program:

A. Signs:

1. 1 square foot to 6 square feet - \$ 100.00
2. 6.1 square feet to 10 square feet - \$ 140.00
3. 10.1 square feet to 20 square feet - \$ 170.00
4. supplementary sign on same post - \$ 50.00

B. Delineators:

1. Design "'A" metal posts - \$ 9.25
2. Design "A" flexible posts-6' - \$ 20.00
3. Design "A" flexible posts-27" - \$ 6.00

C. Guardrail:

1. New "W" Beam rail (per foot) - \$ 8.00
2. "W" Beam end treatment (each) - \$ 1,000.00
3. New concrete rail (per foot) - \$ 16.00
4. New concrete end tapers (per foot) - \$ 16.00

Even though Great Falls street and traffic crews are capable of performing a good deal of work, costs related to physical changes in the roadway section are based on contract prices in order to correlate with costs requiring contract bid letting. The costs do not include administrative, engineering or field layout for the recommended improvements at sites which would require final design plans. Engineering design will generally be required to produce contract plans and specifications. These costs should be evaluated prior to planning improvement projects requiring bids.

BENEFITS

Estimated benefits are made by applying accident reduction forecasts based on the type of improvement recommended. The forecasts are based on the subjective evaluation by an experienced traffic engineer. This evaluation is aided by knowledge of accident experience at similar locations with the improvements existing. Also statistical studies relating certain improvements to accident reduction are used as a guide ie, Roy Jorgenson and Associates, *"Evaluation of Criteria for Safety Improvements on the Highway"* (Washington, D.C.: U.S. Bureau of Public Roads, Office of Highway Safety, 1966. p. 316).

The forecasted reduction is expressed as a percentage of each type of accident. This percentage is multiplied by the percentage of all accidents represented by each type. The total percent reduction of all accidents at each site is the sum of all accidents reduction percentages for each type.

The method used to compute benefits in this study follows the Montana Department of Transportation's procedures. Those procedures were programmed for Quattro Pro Computer Software which provides a tabular summary of all variables in the computation.

If applied consistently, the economic benefit computation will provide a realistic estimate of average economic savings to society. The benefit amount should not be

interpreted as a dollar value that Great Falls will receive as a result of dollar outlay. It is a figure used to quantify the economic benefit to society that would occur if a certain number of accidents did not occur.

B/C RATIO

The B/C provides a numerical reference to the relative value of the recommended improvements. It is the desire of any improvement project to have a benefit-cost (B/C) ratio in excess of 1.0. If the B/C is less than 1.0 the project would have questionable justification. In this study, only one of the sites had a B/C less than one. However, this site requires a new signal installation to meet current traffic control device standards. The new signal would have benefits beyond the site itself which could not be factored into the B/C calculation.

Table 11 is a computer generated summary of the B/C ranking for the twenty five study sites. From this table it can be seen that the total capital cost of improvements would be approximately \$ 194,000 or about \$7,700 per site. The total projected benefit would be approximately \$ 440,000, annually. The average B/C ratio value was computed to be in excess of 37, which translates into a 3700% return on investment.

The B/C indicator values encompass the full range of values from 0 to 100. The average value is 56. An explanation of the B/C indicator value is given in the priority index section of this report.

TABLE 11. SITE RANKING BY BENEFIT/COST RATIOS

R N K	#	SITE LOCATION	PROJ LIFE	COSTS			BENEFITS							B/C RATIO	IND VAL
				CAPITOL COST	EQUIV ANNUAL COST	ANNUAL MAINT. COST CH.	TOTAL ANNUAL COST	Q	Ati	Apd	PFI	Ppd	ANNUAL BENEFIT		
1		SEVENTH AVE S	5	\$450	\$119	\$45	\$164	\$37,164	1.90	1.27	70%	52%	\$50,896	310.83	100
2		EIGHT AVENUE S	5	\$680	\$179	\$68	\$247	\$37,164	2.22	1.27	50%	38%	\$42,303	171.00	100
3		FIFTH AVENUE S	5	\$1,220	\$322	\$122	\$444	\$37,164	1.58	0.83	64%	70%	\$38,682	87.15	97
4		NINTH AVENUE S	5	\$2,120	\$559	\$212	\$771	\$37,164	1.27	3.80	60%	52%	\$31,500	40.84	81
5		FIRST AVENUE S	5	\$3,420	\$902	\$342	\$1,244	\$37,164	2.53	1.27	50%	25%	\$47,963	38.57	79
6		EIGHT AVENUE S	5	\$680	\$179	\$68	\$247	\$37,164	0.63	1.27	35%	23%	\$8,756	35.39	77
7		FIFTH AVENUE N	5	\$880	\$232	\$88	\$320	\$37,164	0.63	1.27	40%	20%	\$9,896	30.88	74
8		SECOND AVENUE S	7	\$4,130	\$848	\$413	\$1,281	\$37,164	2.22	3.80	43%	45%	\$38,343	30.40	74
9		THIRD AVENUE S	5	\$700	\$185	\$70	\$255	\$37,164	0.32	1.27	50%	50%	\$6,898	27.09	72
10		EIGHT AVENUE S	5	\$2,040	\$538	\$204	\$742	\$37,164	1.27	1.90	33%	22%	\$16,312	21.96	67
11		ELEVENTH AVE S	5	\$2,300	\$607	\$230	\$837	\$37,164	0.63	2.53	60%	53%	\$16,287	19.48	64
12		THIRD AVENUE N	5	\$1,320	\$348	\$132	\$480	\$37,164	0.32	1.58	70%	42%	\$9,322	19.41	64
13		SECOND AVENUE S	5	\$1,080	\$288	\$108	\$397	\$37,164	0.95	1.58	20%	16%	\$7,511	18.94	64
14		CENTRAL AVENUE	7	\$6,400	\$1,315	\$440	\$1,755	\$37,164	1.27	6.96	40%	48%	\$24,066	13.72	57
15		FIFTH AVENUE S	5	\$330	\$87	\$33	\$120	\$37,164	0.00	2.22	0%	43%	\$1,443	12.02	54
16		SECOND AVENUE S	5	\$2,380	\$628	\$238	\$866	\$37,164	0.32	2.53	60%	38%	\$8,584	9.91	50
17		SECOND AVENUE S	7	\$8,650	\$1,777	\$500	\$2,277	\$37,164	1.27	3.48	30%	50%	\$16,891	7.42	44
18		FIFTH AVENUE S	5	\$700	\$185	\$70	\$255	\$37,164	0.00	1.90	0%	53%	\$1,525	5.99	39
19		FIRST AVENUE S	7	\$10,940	\$2,247	\$600	\$2,647	\$37,164	0.63	3.16	60%	54%	\$16,843	5.92	39
20		THIRTEENTH AVE S	5	\$1,760	\$464	\$176	\$640	\$37,164	0.32	3.16	20%	19%	\$3,287	5.13	36
21		ELEVENTH AVE S	5	\$8,120	\$2,142	\$812	\$2,954	\$37,164	1.27	3.80	20%	33%	\$11,401	3.86	29
22		SIXTEENTH AVE NW	10	\$15,360	\$2,500	\$600	\$3,100	\$37,164	0.63	0.95	30%	40%	\$7,702	2.48	20
23		THIRD AVENUE S	5	\$2,100	\$554	\$210	\$764	\$37,164	0.00	2.22	0%	33%	\$1,107	1.45	8
24		CENTRAL AVENUE	10	\$58,520	\$9,524	\$5,852	\$15,376	\$37,164	1.27	4.43	30%	27%	\$16,066	1.04	1
25		CENTRAL AVENUE	10	\$58,520	\$9,524	\$1,000	\$10,524	\$37,164	0.63	3.16	20%	21%	\$5,758	0.55	0
TOTALS :														\$439,352	
AVERAGES :														\$17,574	56
														36.86	

PRIORITY INDEX

The ranking of site improvement priorities cannot be directly dependent on the hazard ranking of the study sites. The value of the improvements must enter into the priority listing in the form of the benefit/cost ratio (B/C). The method of developing a composite Hazard Index - B/C listing must be dependent on the relative index scale used in the hazard index computation. Therefore, a correlation of scale between the B/C ratio and hazard indicator value was developed on the following assumptions:

1. The contributing conditions creating hazards at each site and the resulting hazard ranking is relatively independent of the cost of correcting these conditions.
2. Benefits to be derived from correcting hazardous situations at each site is indirectly proportional to the degree of hazardness.
3. The benefit/cost ratio, by virtue of benefit computation, is indirectly proportional to the number of accidents indicator and severity indicator, both of which are curvilinear functions.
4. The benefit/cost ratios can be rated on a scale of 0 to 100 based on a curvilinear function.
5. The B/C ratio of 1.0 is equivalent to an indicator value of 0 and the upper limit (indicator value = 100) must be chosen to encompass the majority of sites.

In this case, a B/C of 100.0 and above assumes the indicator value of 100. Based on these assumptions a graphic plot of the B/C ratio versus B/C indicator value has been established and it is shown in Figure 10. Since it has been graphed on semi-log paper the line appears linear.

Since the relative weighting of benefit/costs and hazardness is a controversial subject which would require research beyond the scope of this report, it is felt that the priority index should be based on 33% weighting for the benefit-cost ratio and 67%

weight on the hazard index. Therefore, to establish a priority index the following formula has been devised:

$$\text{Priority Index} = (\text{Hazard Index}) \times (0.67) \\ + (\text{Benefit/Cost Indicator}) \times (0.33)$$

Table 12. is the computer generated summary of priority ranking based on the composite hazard index - benefit/cost index values.

TABLE 12. SITE RANKING BY PRIORITY INDEX - SUMMARY

PRIORITY NUMBER	AVENUE	STREET	HAZARD INDEX	WEIGHTED VALUE	BEN/COST INDEX	WEIGHTED VALUE	PRIORITY INDEX
1	SEVENTH AVE S	13TH STREET S	62.40	41.81	100	33.00	74.81
2	FIFTH AVENUE S	13TH STREET S	57.40	38.46	97	32.01	70.47
3	EIGHT AVENUE S	10TH STREET S	53.00	35.51	100	33.00	68.51
4	NINTH AVENUE S	9TH STREET S	59.70	40.00	81	26.73	66.73
5	ELEVENTH AVE S	29TH STREET S	64.20	43.01	64	21.12	64.13
6	EIGHT AVENUE S	7TH STREET S	55.50	37.19	77	25.41	62.60
7	FIRST AVENUE S	8TH STREET S	54.50	36.52	79	26.07	62.59
8	FIFTH AVENUE N	11TH STREET N	55.70	37.32	74	24.42	61.74
9	EIGHT AVENUE S	9TH STREET S	58.30	39.06	67	22.11	61.17
10	SECOND AVENUE S	9TH STREET S	54.00	36.18	74	24.42	60.60
11	THIRD AVENUE S	8TH STREET S	52.30	35.04	72	23.76	58.80
12	SECOND AVENUE S	23RD STREET S	54.30	36.38	64	21.12	57.50
13	THIRTEENTH AVE S	9TH STREET S	63.90	42.81	36	11.88	54.69
14	FIFTH AVENUE S	23RD STREET S	53.80	36.05	54	17.82	53.87
15	CENTRAL AVENUE	9TH STREET S	52.00	34.84	57	18.81	53.65
16	THIRD AVENUE N	4TH STREET N	48.50	32.50	64	21.12	53.62
17	SECOND AVENUE S	4TH STREET S	52.10	34.91	50	16.50	51.41
18	FIRST AVENUE S	PARK DRIVE	55.50	37.19	39	12.87	50.06
19	SECOND AVENUE S	2ND STREET S	52.00	34.84	44	14.52	49.36
20	ELEVENTH AVE S	26TH STREET S	58.10	38.93	29	9.57	48.50
21	SIXTEENTH AVE NW	5 - 6TH ST NW	56.00	37.52	20	6.60	44.12
22	FIFTH AVENUE S	7TH STREET S	41.50	27.81	39	12.87	40.68
23	CENTRAL AVENUE	7TH STREET S	54.50	36.52	1	0.33	36.85
24	CENTRAL AVENUE	4TH STREET S	52.80	35.38	0	0.00	35.38
25	THIRD AVENUE S	46TH STREET S	48.80	32.70	8	2.64	35.34

AVERAGE VALUES :	54.83	36.74	55.60	18.35	55.09
STANDARD DEVIATIONS :	4.80	3.22	28.29	9.34	10.63

$$\text{PRIORITY INDEX} = (\text{HAZARD INDEX} \times 0.67) + (\text{BENEFIT/COST INDEX} \times 0.33)$$

IMPLEMENTATION

Within Table 13, the priority lists have been arranged in a manner in which budget considerations can readily be applied in the decision to proceed with improvements. The priority ranking was the major consideration in selecting which sites will be receiving funds first. Since limited funds are available, it is usually necessary to skip over a few higher priority projects to improve a greater number of sites as soon as possible. The listing assumes that eligible project costs will be funded by MDoT Off-system Safety funds. The MDoT project funding limit is less than \$10,000 per project period, or else formal bid letting procedures would be required by MDoT. This dollar figure is used as the criteria to define construction groupings. The estimated costs not covered by MDoT funds are considered City funding requirements. If the Great Falls Street and Traffic Division performs this work, the actual costs would probably be much less.

There is no timetable given for these improvements. It may be conceivable that MDoT could fund more than one of the site groups in a single year, depending on available funding. The City will want to request funding from MDoT by submitting this report to Dave Johnson, P.E., Preconstruction Engineer.

TABLE 13. PROJECT IMPLEMENTATION SCHEDULE

PRIORITY NO.	AVENUE	STREET	COST ESTIMATE	MDOT	CITY
				ELIGIBLE FUNDS	
1	SEVENTH AVE S	13TH STREET	\$450	\$200	\$250
2	FIFTH AVENUE S	13TH STREET	\$1,220	\$600	\$620
3	EIGHT AVENUE S	10TH STREET	\$680	\$600	\$80
4	NINTH AVENUE S	9TH STREET S	\$2,120	\$1,380	\$740
5	ELEVENTH AVE S	29TH STREET	\$2,300	\$1,480	\$820
6	EIGHT AVENUE S	7TH STREET S	\$680	\$600	\$80
7	FIRST AVENUE S	8TH STREET S	\$3,420	\$780	\$2,640
8	FIFTH AVENUE N	11TH STREET	\$880	\$800	\$80
9	EIGHT AVENUE S	9TH STREET S	\$2,040	\$800	\$1,240
10	SECOND AVENUE S	9TH STREET S	\$4,130	\$2,000	\$2,130
11	THIRD AVENUE S	8TH STREET S	\$700	\$600	\$100
CONSTRUCTION GROUP #1 TOTALS =			\$18,620	\$9,840	\$8,780
12	SECOND AVENUE S	23RD STREET	\$1,090	\$400	\$690
13	THIRTEENTH AVE S	9TH STREET S	\$1,760	\$1,080	\$680
14	FIFTH AVENUE S	23RD STREET	\$330	\$200	\$130
15	CENTRAL AVENUE	9TH STREET S	\$6,400	\$1,120	\$5,280
16	THIRD AVENUE N	4TH STREET N	\$1,320	\$600	\$720
17	SECOND AVENUE S	4TH STREET S	\$2,380	\$640	\$1,740
18	FIRST AVENUE S	PARK DRIVE	\$10,940	\$1,780	\$9,160
19	SECOND AVENUE S	2ND STREET S	\$8,650	\$1,500	\$7,150
20	ELEVENTH AVE S	26TH STREET	\$8,120	\$600	\$7,520
21	SIXTEENTH AVE NW	5 - 6TH ST NW	\$15,360	\$1,080	\$14,280
22	FIFTH AVENUE S	7TH STREET S	\$700	\$600	\$100
CONSTRUCTION GROUP #2 TOTALS =			\$57,050	\$9,600	\$47,450
23	CENTRAL AVENUE	7TH STREET S	\$58,520	\$1,120	\$57,400
24	CENTRAL AVENUE	4TH STREET S	\$58,520	\$1,120	\$57,400
25	THIRD AVENUE S	46TH STREET	\$2,100	\$1,080	\$1,020
CONSTRUCTION GROUP #3 TOTALS =			\$119,140	\$3,320	\$115,820
TOTAL CONSTRUCTION COSTS =			\$194,810	\$22,760	\$172,050

STREET CORRIDORS

Two separate street segments were identified as having continuous accidents cluster sites along their length, during the study screening process. Since a number of the intersections involved in this corridor were on FAU routes, data for these intersections were eliminated and thus accurate statistical data is not available within the scope of this study. However, conditions and operations along these corridors were observed and general recommendations can be made with regard to improving the safety and efficiency of these corridors. The following narratives present those recommendations.

CENTRAL AVENUE

Central Avenue is a two way east-west street that traverses the CBD of Great Falls. The portion of Central Avenue identified as an accident problem corridor runs between Park Drive and 9th Street. The intersections of 4th, 7th and 9th Streets are included as specific sites within this study. The remaining intersections in this corridor were either on the FAU system or did not rank high enough for inclusion as a specific site.

Central Avenue is located between 1st Avenue N. and 1st Avenue S., two one-way streets, and thus serves a good deal of circulation traffic within the CBD area. The street is characterized by two lane operation on a 52' wide street with a center turn lane. There are mid-block crosswalks marked and signed on almost every block. There is, apparently, significant pedestrian volumes crossing Central. Traffic signals with corner pole top mounting exist at the intersections of 1st, 2nd, 3rd, 4th, 5th, 6th and 7th Streets. A newer mast arm mounted signal installation exists at the intersection of 9th Street and Central. There was no apparent progression system in operation during study observation periods.

Accident problems along the corridor consist mostly of rear end and angle accidents. An extremely high percentage of accidents occur during late night hours. After investigating the reason for night accidents, it was discovered that this street is used by the local teenagers as a "drag" or "point", which they cruise on weekend nights. Week night observations did not indicate this phenomenon, but it was noted that this corridor is adequately lighted and the signals operate on flash mode with yellow indications on Central.

The existing pole top, corner mounted signals are completely inadequate for the conditions encountered. The streets are too wide for the signals to be within an acceptable cone of vision and they are easily blocked by leading traffic and stopped vehicles. More than one signal indication is needed for each approach to maintain visibility. The problems are compounded since intersections on either side of Central have mast arm mounted signals. Those signals are visible for blocks in advance. Since drivers tend to drive at points and controls on the horizon, even those familiar with the area tend to lose sight of the corner signals, since they are not visible until the vehicle arrives at the intersection.

Minimum changes to the corridor may be made by changing the flash operation to all red or eliminating flashing operations entirely. However, either option would not significantly improve the corridor's safety and may even be a detriment at some of the intersections. The only rational improvement that could be implemented would involve installation of a new signal system which would provide multiple signal indications within the acceptable cone of vision. This would require new poles with mast arms. Since the aesthetics of this street are a concern, the signal poles could be a designer type installation such as manufactured by Ameron Pole and other suppliers. These poles consist of dual box beam type tubes in a variety of antique and modern finishes. However, designer poles may add 20 or 30% to the cost of the project.

Along with new poles and mast arms the controllers should be replaced with new solid state signal controllers capable of being interconnected and programmed for

signal progression and coordination with the remainder of the CBD area. This would also allow for installation of emergency vehicle preemption systems throughout the system.

No work other than maintenance should be completed on the existing signals without entirely reconstructing the entire signal system, which includes recommended improvements to the intersections of 4th and 7th Streets, since new installations would have to meet requirements of MUTCD. The City of Great Falls should plan and implement a program to replace the existing signals as their budgets would allow. Benefits from the program can be expected in the form of improved safety. A recent report, *Impact of Mast-Mounted Signal Heads on Accident Reduction*, Russi P. Bhesania, *ITE Journal*, Oct. 1991, indicates that accident reductions as high as 63% for certain type of accidents have been experienced, when the pole top signals were converted.

NINTH STREET SOUTH

Ninth Street South is a two lane two way street which serves as an arterial street that traverses the entire City of Great Falls. It has the highest traffic volumes of all the study sites. The problem area under consideration is located between 10th Avenue South and Central Avenue. Within this section, 9th Street S. is approximately 48 feet wide. It has varying degrees of vertical grades and undulating humps in the vertical profile. Pavement conditions range from good to poor. Access is uncontrolled and there is parking on both sides of the street.

There were approximately 96 accidents along the length of the corridor in the 3 year two month reporting period. When traffic volumes of approximately 13,500 ADT is factored into the corridor length of 1.0 miles, the accident rate is 6.16 accidents per million vehicle miles. Capacity of this street section at LOS "C" is approximately 9,000 to 10,000 ADT. As traffic volumes increase, accident experience will also increase.

No one significant recurring problem can be distinguished along this corridor other than access control and street capacity. Because traffic volumes will continue to increase on 9th Street S., it is recommended that plans should be developed to deal with capacity problems in a manner which will also minimize drive approach access problems. Since existing on-street parking is sporadic and demand doesn't generally seem to be great, parking should be eliminated on both sides of 9th Street S. and the street should be remarked for three lanes of traffic. A continuous center left turn lane would increase existing capacity significantly and removal of parked cars would eliminate sight distance problems at alleys, drive approaches and intersections. Costs associated with these improvements would be approximately \$ 80,000 to \$100,000 and would require possible provisions for replacement parking in some extreme cases.

The City of Great Falls has already begun design on a project to reconstruct 9th Street South. It is recommended that the new street section design incorporate provisions for improved safety, specifically the following:

1. Parking restrictions to provide adequate intersection sight distance.
2. Consolidation of existing driveways and elimination of approaches within ten feet of intersection curb radii.
3. Provisions for left turn lanes, either continuous or opposing bays.
4. Traffic signal installations with proper mast arm signal lane alignment.
5. Mast arm mounted lane assignment and street name signs.
6. Consistent location of street name signs.

PROGRAM CONTINUATION

Since the basic format of the study has been outlined and an initial priority list established, continuance of this program or a similar program is strongly advised. The findings and recommendations of this study will soon become obsolete without continued updating at least on an annual basis. The following recommendations in the continuance of the program are offered to the City of Great Falls:

1. The City Police Department should continue to be assessed for copies of accident reports.
2. One person should be assessed with the responsibility of the program to insure that all data is being supplied and processed.
3. An agreement with the City Police Department should be made which would modify computer reporting to identify cluster sites or a separate program should be used to store basic data from the police reports as they are received by Technical Operations.
4. Criteria should be developed for the inclusion of additional sites to be analyzed, such as number of accidents, accident rate and severity.
5. Coordinate existing traffic counting programs to include areas that may not currently be covered. With broad enough coverage, estimates of volumes on all street segments can be made for screening purposes.
6. Analyze new sites according to all or selected procedures of this study and include them in the priority list when warranted.

All of the data processing and storage can be handled by most computer spreadsheet software programs. A copy of the data disk has been provided to the City of Great Falls. If translation problems occur between these data files and the City's spread sheet program, they can be translated to a ASC II file.

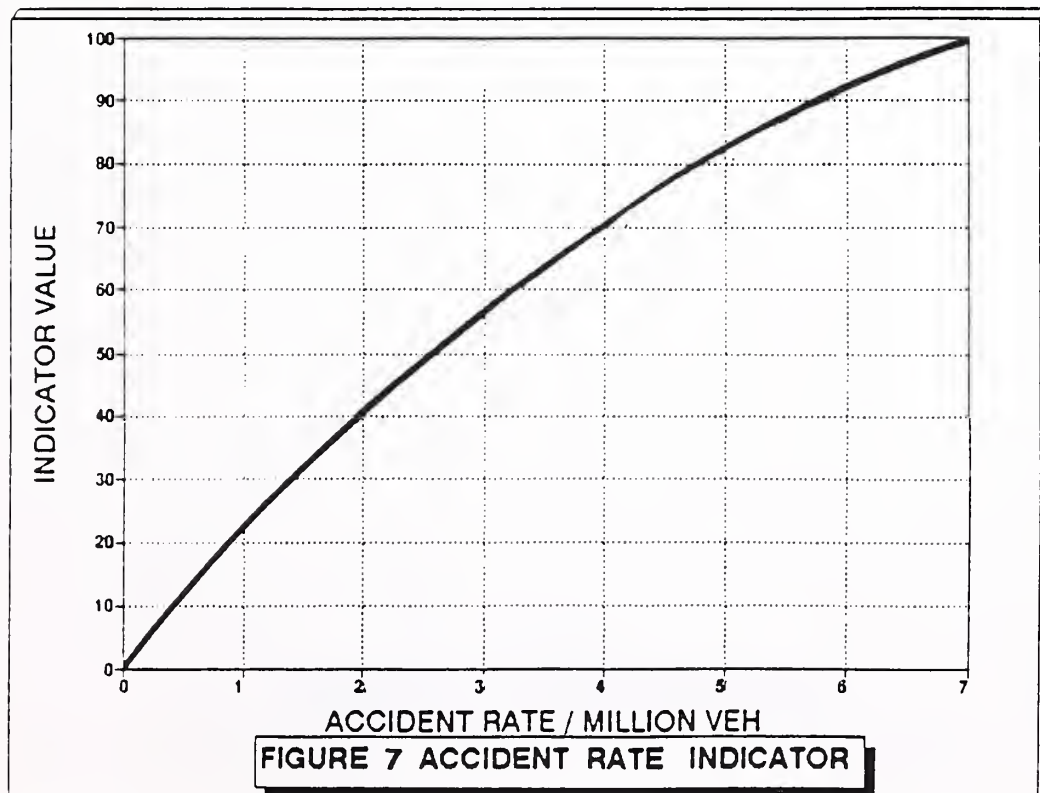
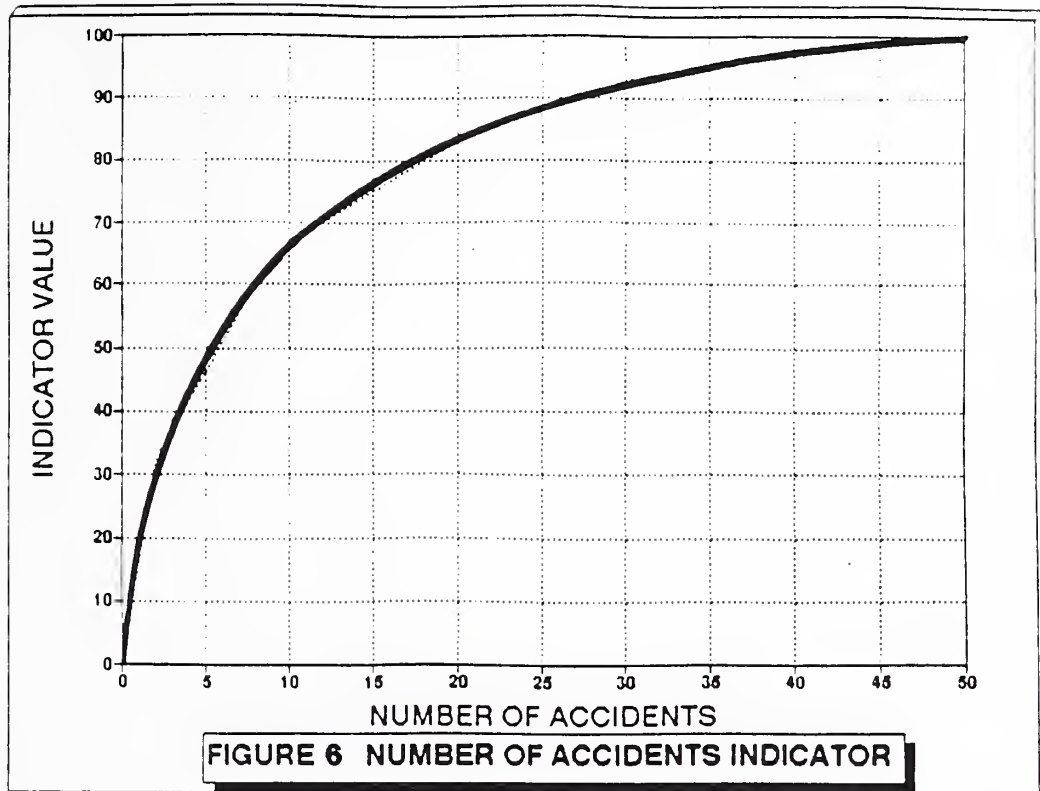
REPORT

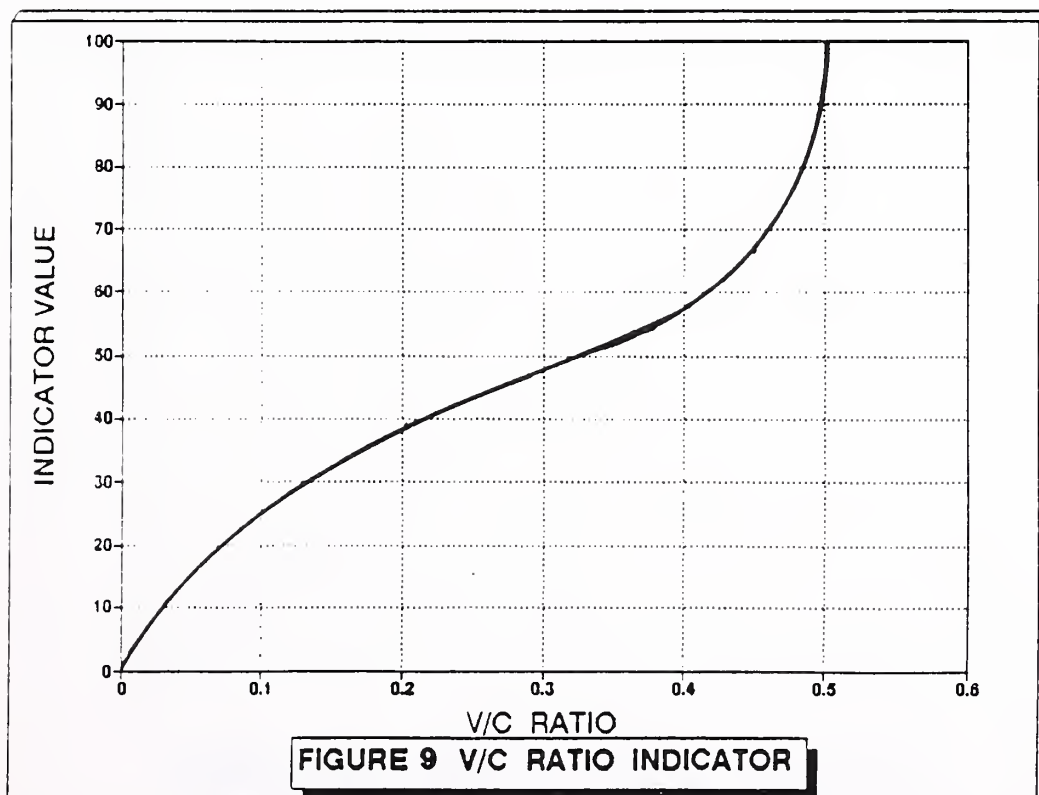
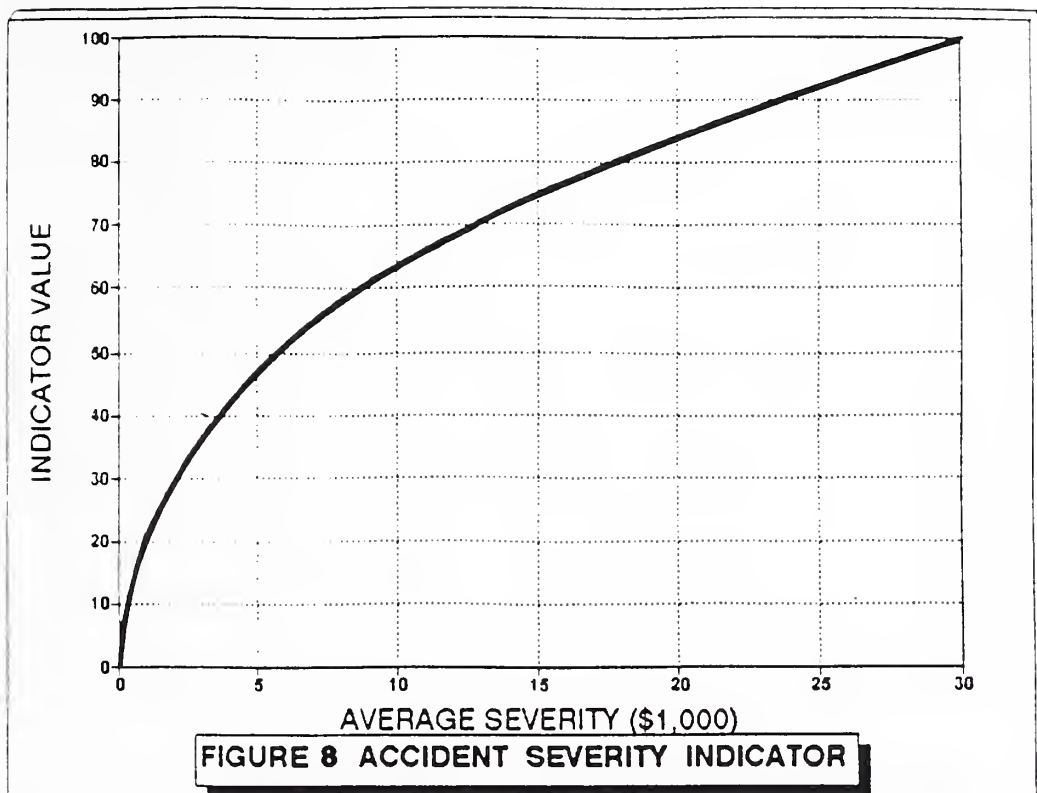
FIGURES

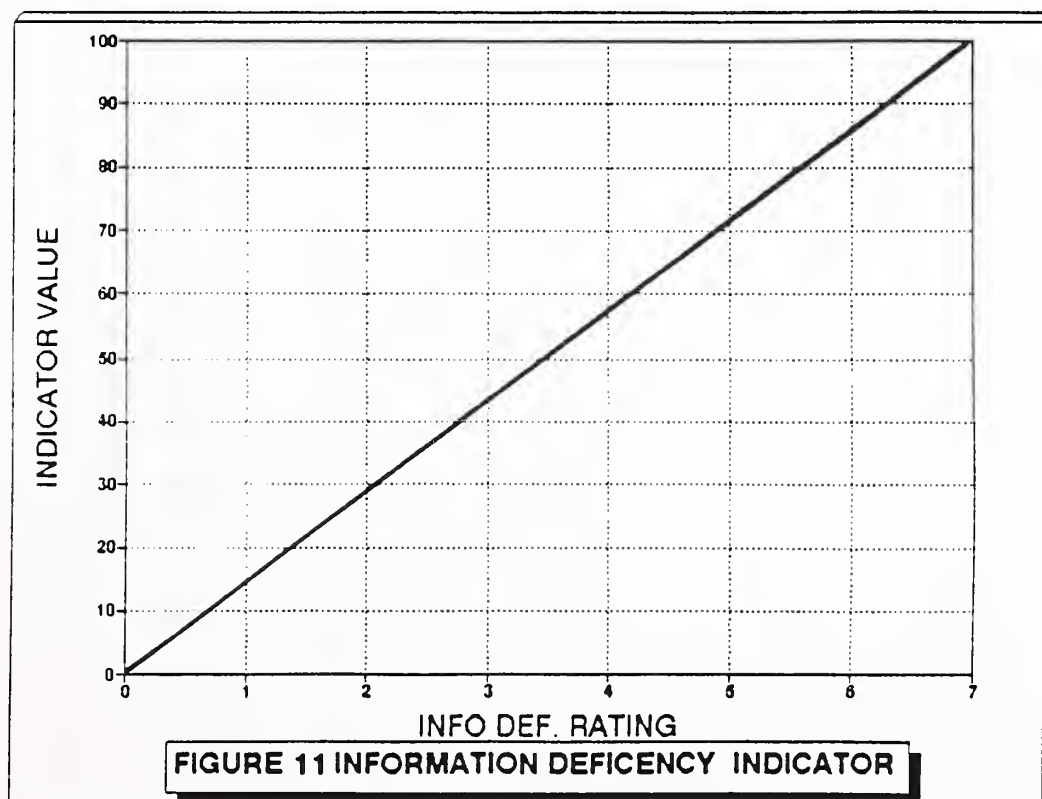
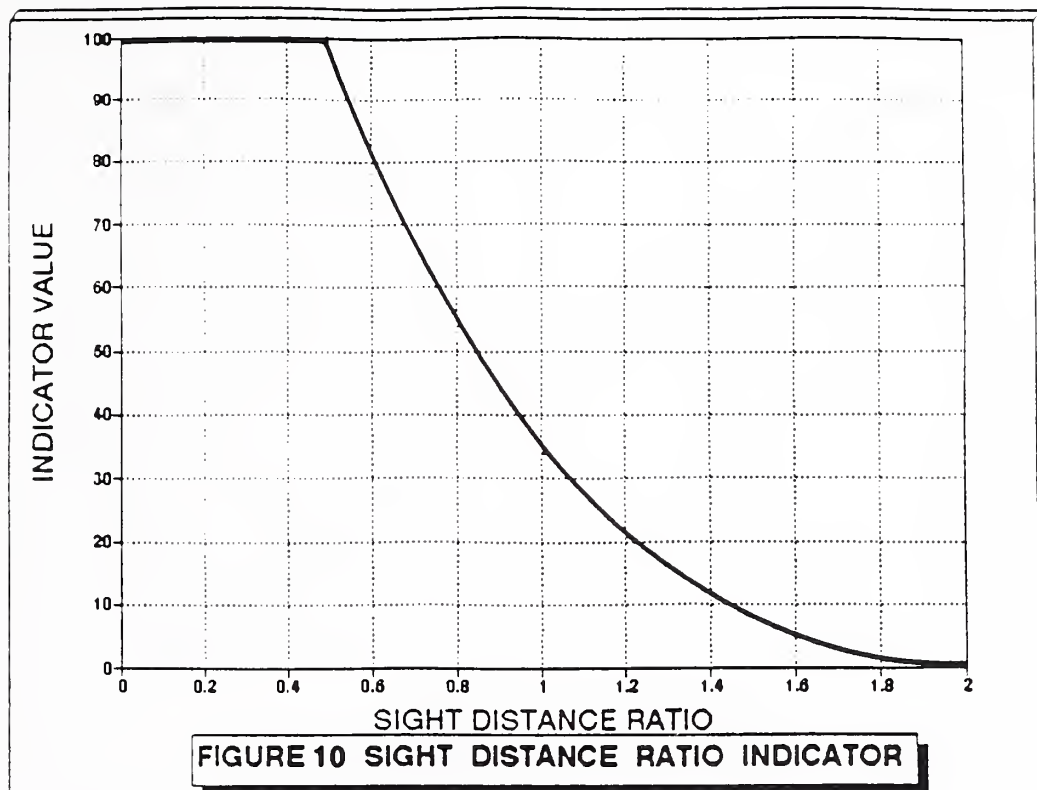
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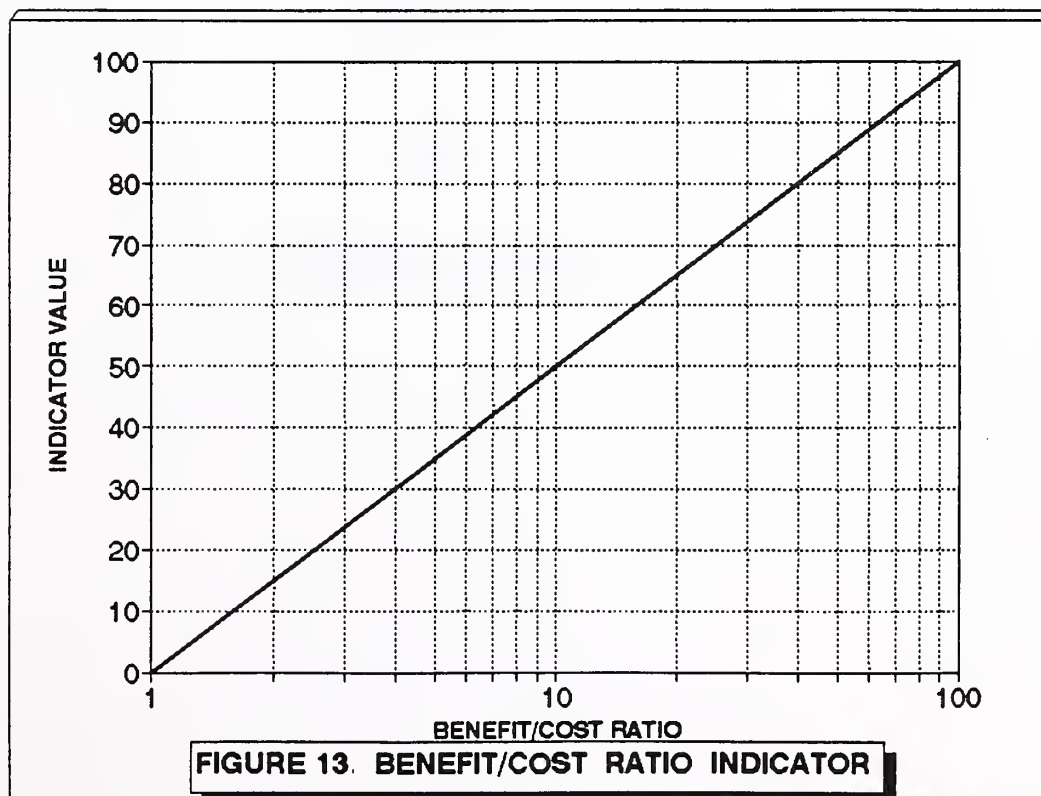
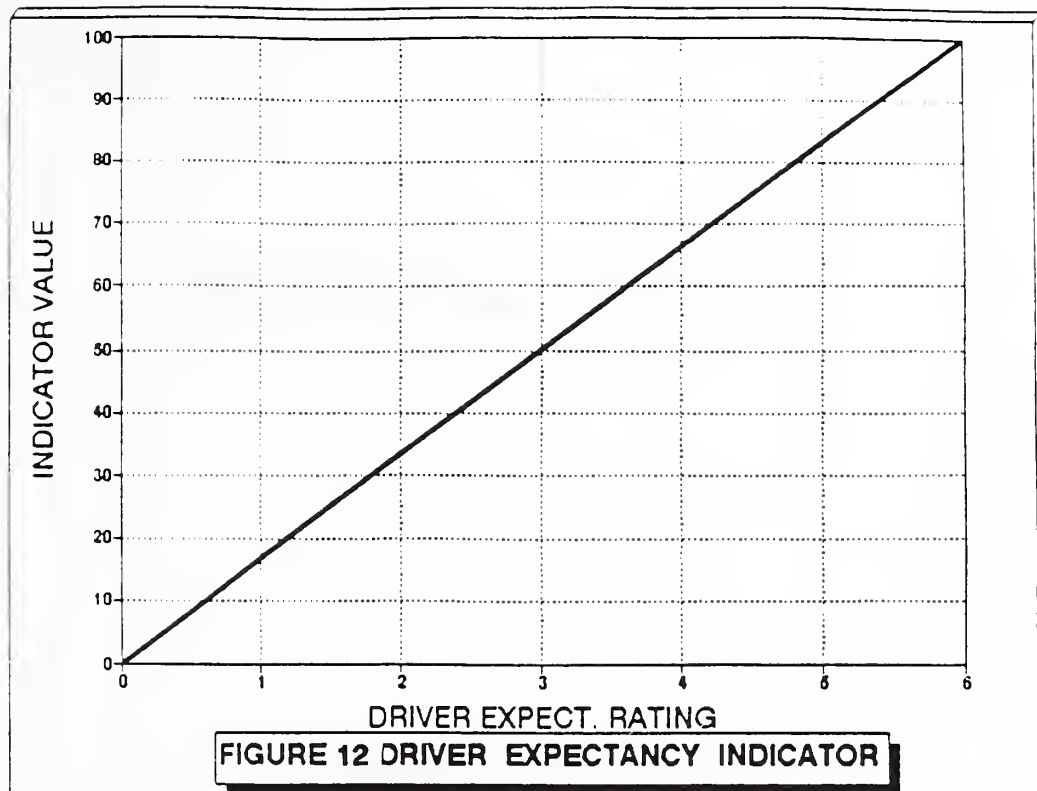
INDICATOR

VALUES









INDIVIDUAL SITES

SPECIFIC

DATA

&

ANALYSIS

**SITE
NUMBER**

1

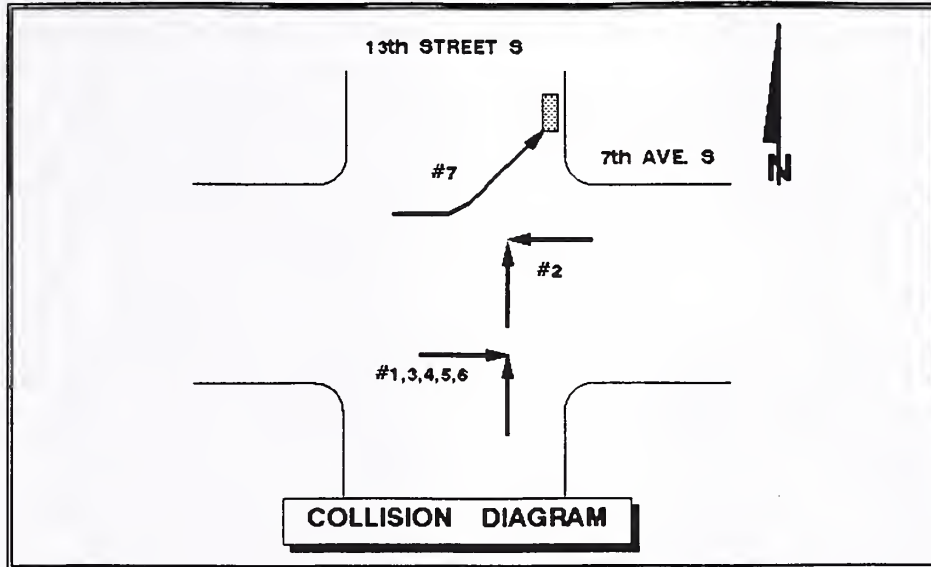
SEVENTH AVENUE S

and

13TH STREET S

ACCIDENT SUMMARY

7TH AVENUE S & 13TH STREET S

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
0	1988	NO. INJURY	3
3	1989	NO. FATAL	0
4	1990	NO. PDO	4
0	1991	Pers Inj = 6	
7	TOTAL	NIGHTTIME	29%

TYPES	NUMBER	ROAD	
ANGLE	6	DRY	86%
REAR END	0	WET	14%
SIDESWIPE	0	SNOW	0%
PEDEST.	0	ICE	0%
OTHER	1	OTHER	0%



SEVENTH AVENUE S, LOOKING EAST



SEVENTH AVENUE S, LOOKING WEST



13TH STREET S, LOOKING NORTH



13TH STREET S, LOOKING SOUTH

TRAFFIC OPERATIONS

Thirteenth Street South is one of many north-south streets which receives spill-over traffic from 10th Avenue South. A signalized intersection at 13th St. S. and 10th Ave. S. creates traffic demand by providing easier access to the east-west arterial, thus traffic volumes on 13th are higher than what would be expected on a local street. Traffic volumes on 13th tend to increase at intersections closer to 10th Avenue South. Thus, traffic on 13th is 4 to 5 times heavier than on 7th Avenue South.

This intersection would appear, to the driver, similar to any other intersection of local streets, except the southbound driver is able to see the signal at 10th, which provides a subtle clue that he may be on a through street. A driver would also tend to time his approach with the intent of making a green light. Both of these, no matter how minor, would effect the driver's expectations as far as his reaction to unexpected side street traffic. In addition there is a tall hedge in the southwest corner that restricts sight distance to the minimum required for 25 mph speeds. Vehicles traveling at speeds in excess of 25 mph would require superior reflexes to avoid a collision.

IMPROVEMENTS

Five angle accidents between westbound and southbound vehicles seem to support the observed operational problems encountered at this intersection. Because of extreme difference in approach leg traffic volumes; the presence of visual miscues; potential sight distance restrictions; and accident history, it is recommended that this intersection be controlled by stop signs on the 7th Avenue South approaches. There are no apparent thru street patterns in this area or difficult grades which would preclude the use of this control feature. In addition to stop signs, it is advised that a short section of centerline and stop bars be painted on the 7th Avenue approaches to reinforce the stop requirement. Curb should also be painted yellow, twenty feet from the end radius points to remind drivers of corner parking restrictions.

SEVENTH AVENUE S. & 13TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1500
SOUTH APP	1600
EAST APP	300
WEST APP	300

EXISTING CONTROL:

NONE	YES
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YIELD	
STOP	YES
SIGNAL	
MARKING	YES
WARNING	
GUIDANCE	

ESTIMATED COST:

TOTAL	\$450
MDoT FUND	\$200
CITY FUND	\$250

% ACCIDENT REDUCTION:

INJ/FTL	70%
PDO	53%

BENEFIT/COST RATIO:

310.83

	INDEX VALUE	SITE RANK
# ACCIDENTS	58	17
ACCIDENT RATE	61	4
SEVERITY	66	3
VOL/CAPACITY	9	25
SIGHT DIST.	35	19
DRIVER EXPECT	100	3
INFO DEFICIENT	75	8
HAZARD INDEX	62.4	3
B/C RATIO	100	1

PRIORITY	74.8	1
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**SITE
NUMBER**

2

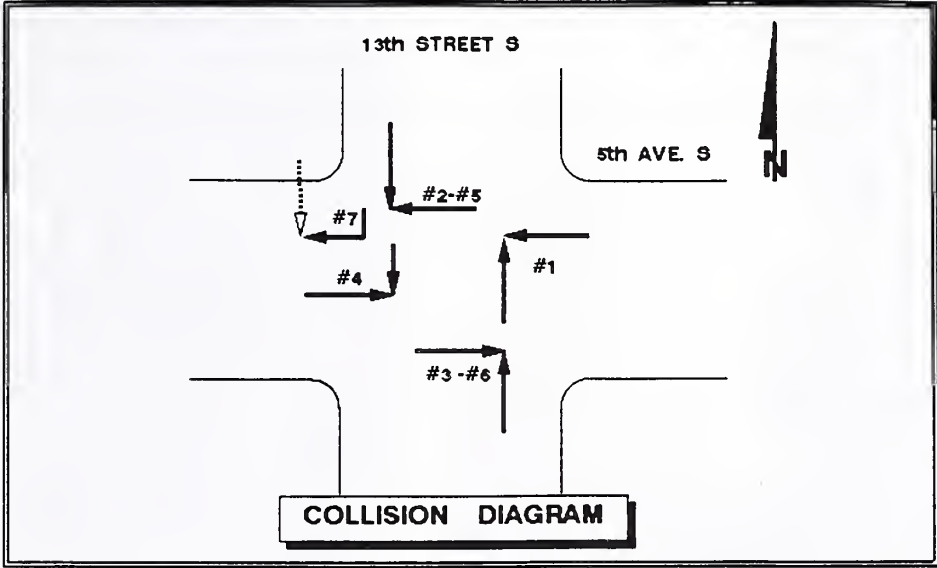
5TH AVENUE S.

and

13TH STREET S

ACCIDENT SUMMARY

5TH AVENUE S & 13TH STREET S

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
3	1988	NO. INJURY	5
2	1989	NO. FATAL	0
2	1990	NO. PDO	2
0	1991	Pers Inj = 5	
7	TOTAL	NIGHTTIME	14%

TYPES	NUMBER	ROAD	
ANGLE	6	DRY	71%
REAR END	0	WET	14%
SIDESWIPE	0	SNOW	14%
PEDEST.	1	ICE	0%
OTHER	0	OTHER	0%



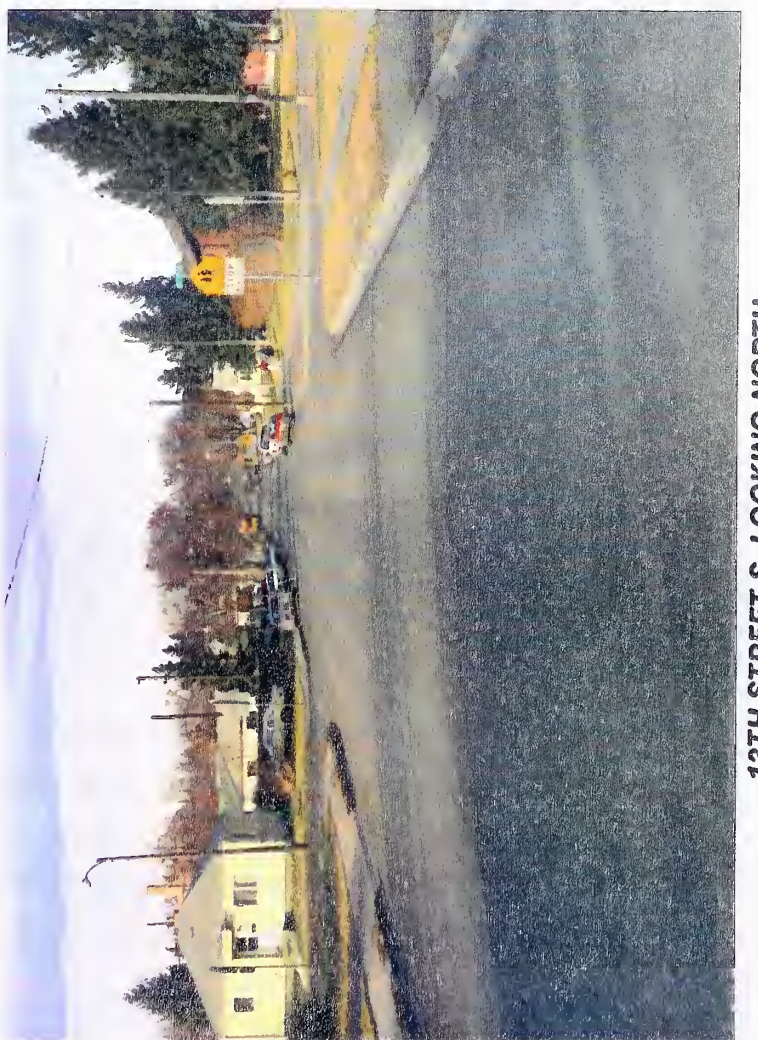
FIFTH AVENUE S, LOOKING WEST



13TH STREET S, LOOKING SOUTH



FIFTH AVENUE S, LOOKING EAST



13TH STREET S, LOOKING NORTH

TRAFFIC OPERATIONS

Thirteenth Street South at 5th Avenue S. is a north-south street which is influenced by ease of access to 10th Avenue South. While being further removed than 7th Avenue S., traffic volumes remain higher than normal for a local street. The intersection of 5th and 13th is also in close proximity to a school which increases traffic and pedestrian volumes during most of the year.

Sight distance in the intersection area is fairly unrestricted and the intersection has a wide open appearance on all approaches. Curb along the north side of 5th Avenue S., east of the intersection is no more than a concrete drainage channel which allows for various types of parking arrangements. No vehicles were parked on that side of the street during observation periods, so it is difficult to tell if a definite problem exists.

School crossing signs and double line cross walk markings exist on all approaches. Appropriate advance school signing is also in place. Several conditions are present which may be factors in accident experience at this intersection. Major traffic flows favor 13th Street S. and this information is supported by centerline striping, which is not present on 5th Ave. South. Cross walk markings are not visible from approaching vehicles and there are no marked parking restrictions for 20 feet in front of the school crossings, which is the distance allowed by state law.

IMPROVEMENTS

Six angle accidents and one pedestrian accident have occurred at this intersection. No definite directional pattern to the accidents indicates that the cause is not directly related to fixed sight obstructions. Therefore the cause may associated with temporary or mobile sight restrictions (parked cars) and the perception of thru street street on 13th St. South.

In order to eliminate these factors, it is recommended that parking restrictions be delineated by painting the curbs yellow and posting parking signs at the most critical areas, the near approach sides. Because of difference in approach leg traffic volumes and accident history, it is recommended that this intersection be controlled by stop signs on the 5th Avenue South approaches.

This would preclude the use of school crossing signs at these approaches, according to MUTCD, and those signs should be removed. Restriping the stop bars and crosswalks using 24" white plastic would improve the visibility and reinforce the intent of signing at this location. Use of 2'x8' white perpendicular marks spaced at two feet is highly recommended for school crossings because marks are 60 times more visible than 8" transverse lines and if spaced properly in the street section, they suffer less traffic wear.

Painting a short section of yellow centerline on the side street to the stop bar is also recommended. The centerline provides more visible surface area than the stop bar alone; draws attention to a change in operation; and helps motorists align their vehicles within the intersection area.

FIFTH AVENUE S. & 13TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1800
SOUTH APP	1700
EAST APP	1000
WEST APP	800

EXISTING CONTROL:

NONE	X-WALK
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
WARNING	
GUIDANCE	

ESTIMATED COST:

TOTAL	\$1,220
MDoT FUND	\$600
CITY FUND	\$620

% ACCIDENT REDUCTION:

INJ/FTL	64%
PDO	70%

BENEFIT/COST RATIO:

87.15

	INDEX VALUE	SITE RANK
# ACCIDENTS	58	15
ACCIDENT RATE	52	7
SEVERITY	60	4
VOL/CAPACITY	19	20
SIGHT DIST.	23	24
DRIVER EXPECT	88	4
INFO DEFICIENT	75	9
HAZARD INDEX	57.4	7
B/C RATIO	97	3

PRIORITY	70.47	2
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**SITE
NUMBER**

3

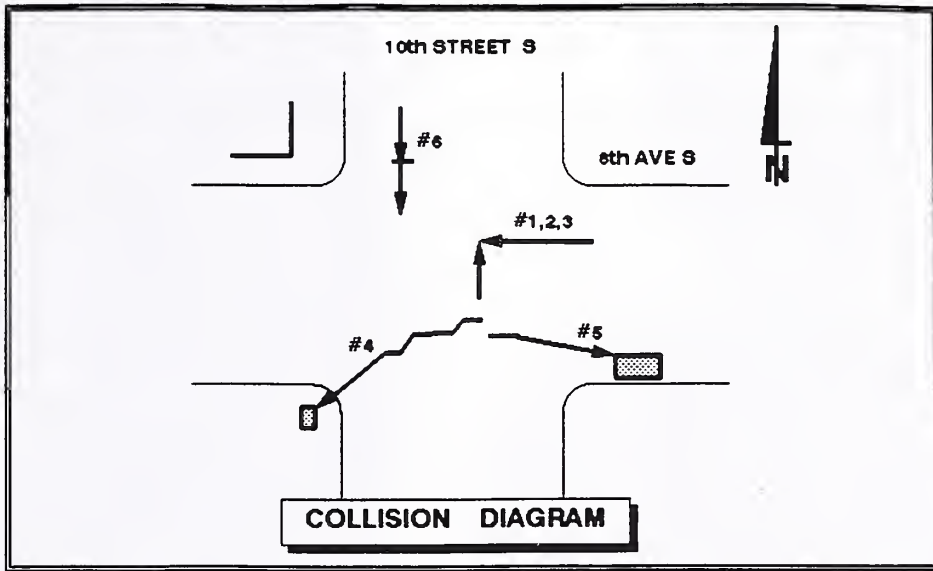
8TH AVENUE S.

and

10TH STREET S

ACCIDENT SUMMARY

8TH AVE. S & 10TH STREET S

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
2	1988	NO. INJURY	2
0	1989	NO. FATAL	0
3	1990	NO. PDO	4
1	1991	Pers ln] = 7	
6	TOTAL	NIGHTIME	33%

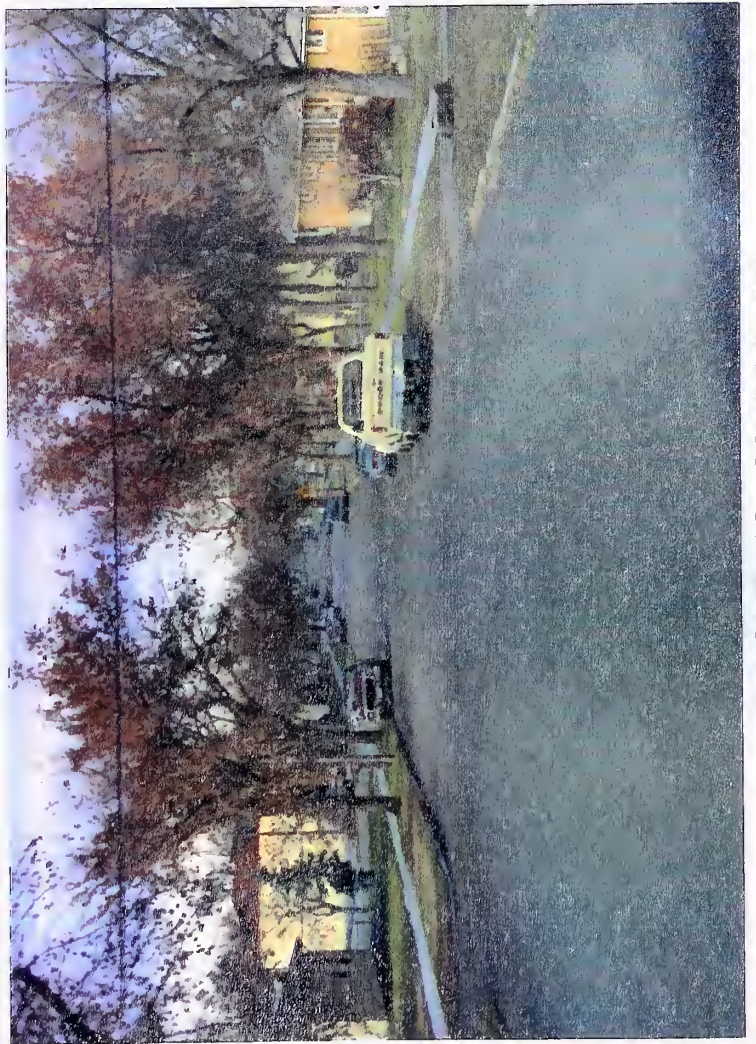
TYPES	NUMBER	ROAD	
ANGLE	3	DRY	33%
REAR END	1	WET	17%
SIDESWIPE	0	SNOW	17%
PEDESTRIAN	0	ICE	33%
OTHER	2	OTHER	0%



EIGHT AVENUE S, LOOKING EAST



EIGHT AVENUE S, LOOKING WEST



10TH STREET S, LOOKING NORTH



10TH STREET S, LOOKING SOUTH

TRAFFIC OPERATIONS

The intersection of 8th Avenue S. and 10th Street S. is typical of most local intersections in the Great Falls urban area. There are no traffic control devices relative to the intersection and there are no street name signs. Traffic on 10th St. S. is slightly higher than on 8th Ave. South. There are no apparent sight restrictions other than tree trunks and parked vehicles.

Problems at this intersection are relegated to mobile and intermittent sight restrictions which may cause partial blockage or blind spots in an approaching drivers view. The exact extent of this problem is difficult to state with any certainty because of the transient nature of the problem.

IMPROVEMENTS

Accident statistics at this intersection indicate that 3 of the six accidents were angle type. Fifty percent of the accidents were on icy or snowy streets which indicates a marginally hazardous situation that becomes more critical when stopping distance is increased. In order to help alleviate this condition, it is recommended that yield signs be placed on the lower volume 8th Ave. S. approaches to slow at least one half of the approach traffic and increase the margin of safety. Curb restrictions at intersections should be reinforced by painting the curbs yellow. New street name signs will also contribute to safety of the intersection by eliminating navigation tasks from the drivers decision making duties.

EIGHT AVENUE S. & 10TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1000
SOUTH APP	900
EAST APP	500
WEST APP	800

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	YES
STOP	
SIGNAL	
MARKING	
WARNING	
GUIDANCE	YES

ESTIMATED COST:

TOTAL	\$680
MDOT FUND	\$600
CITY FUND	\$80

% ACCIDENT REDUCTION:

INJ/FTL	50%
PDO	38%

BENEFIT/COST RATIO:

171

	INDEX VALUE	SITE RANK
# ACCIDENTS	54	20
ACCIDENT RATE	51	8
SEVERITY	74	1
VOL/CAPACITY	14	22
SIGHT DIST.	68	15
DRIVER EXPECT	46	24
INFO DEFICIENT	50	21
HAZARD INDEX	53	17
B/C RATIO	100	2

PRIORITY	68.51	3
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**SITE
NUMBER**

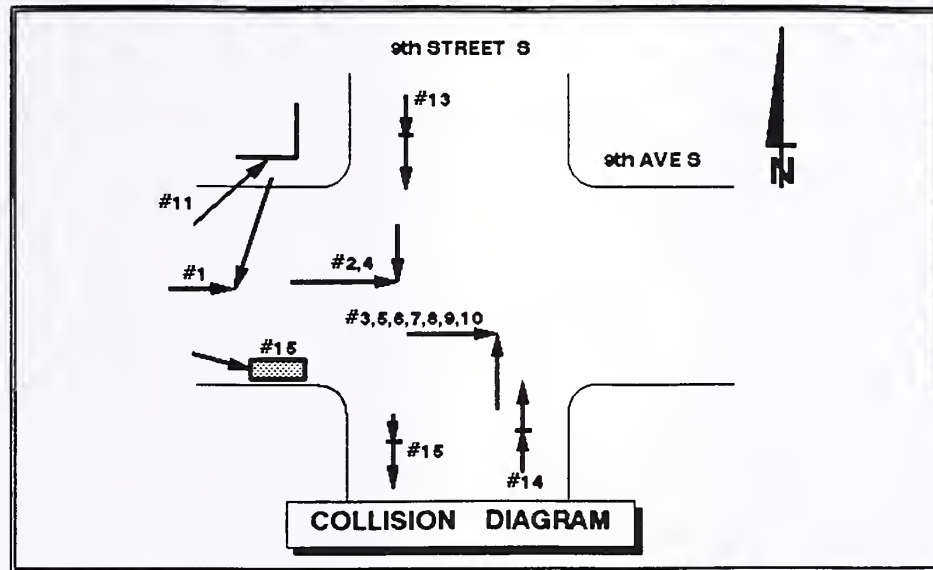
4

9TH AVENUE S.

and

9TH STREET S

ACCIDENT SUMMARY **9TH AVE. S & 9TH STREET S**



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	2	12	88	850	PROP DAM	CLEAR	DRY	DAY
2	ANGLE	5	30	88	1545	PROP DAM	RAIN	WET	DAY
3	ANGLE	12	23	88	1450	PROP DAM	CLEAR	DRY	DAY
4	ANGLE	3	20	89	1757	INJURY	CLEAR	DRY	DAY
5	ANGLE	5	24	89	1126	PROP DAM	CLEAR	DRY	DAY
6	ANGLE	9	10	89	1125	PROP DAM	CLEAR	DRY	DAY
7	ANGLE	2	23	90	1402	PROP DAM	CLEAR	DRY	DAY
8	ANGLE	8	10	90	718	PROP DAM	CLEAR	WET	DAY
9	ANGLE	1	8	91	1444	PROP DAM	CLEAR	ICY	DAY
10	ANGLE	1	26	91	1358	PROP DAM	CLEAR	ICY	DAY
11	FIXED OBJ	9	8	88	2141	PROP DAM	CLEAR	DRY	NITE
12	PARKED CAR	5	17	89	1330	PROP DAM	CLEAR	DRY	DAY
13	REAREND	11	17	89	1445	INJURY	CLEAR	DRY	DAY
14	REAREND	3	14	90	2113	PROP DAM	CLEAR	ICY	NITE
15	REAREND	10	27	90	1223	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO.	ACC.	YEAR		
4	1988	NO. INJURY	2	
5	1989	NO. FATAL	0	
4	1990	NO. PDO	13	
2	1991	Pers Inj = 4		
15	TOTAL	NIGHTTIME	13%	

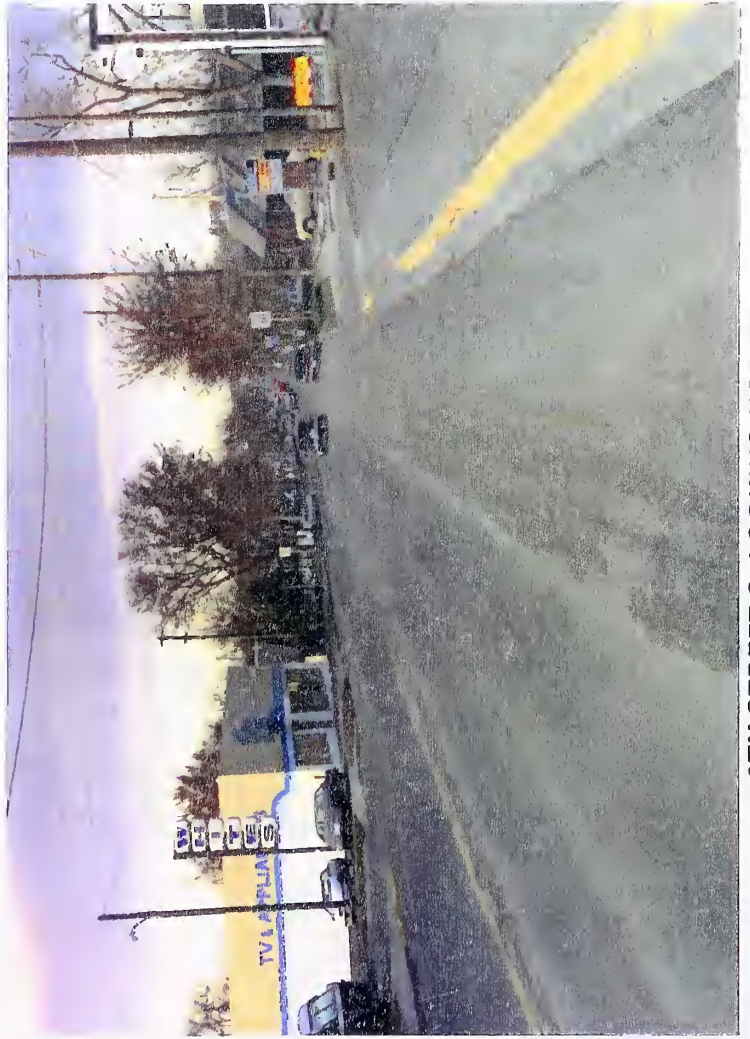
TYPES	NUMBER	ROAD	
ANGLE	10	DRY	67%
REAR END	3	WET	13%
SIDESWIPE	0	SNOW	0%
LEFT TRN	0	ICE	20%
OTHER	2	OTHER	0%



NINTH AVENUE S, LOOKING EAST



NINTH AVENUE S, LOOKING WEST



9TH STREET S, LOOKING NORTH



9TH STREET S. LOOKING SOUTH

TRAFFIC OPERATIONS

Ninth St. S. is the highest volume street at any of the study sites. More details regarding the 9th Street S. corridor can be found in the main body of this report. The obvious operational problems noted at this intersection are lack of access control; heavy turning movements; higher speeds on 9th St. S.; and lack of adequate parking control. All of these problems tend to compound upon each other by reducing sight distance; increasing sight distance requirements; reducing available crossing gaps; and overloading the drivers cognitive abilities. Parking in the southwest corner of the intersection was the most critical observation made and this situation is reflected by seven angle accidents occurring in that intersection quadrant. Increasing traffic volumes at this intersection will undoubtedly magnify the current accident problem.

Also a large factor which may be contributing to accidents at this location is the close proximity of 9th Street's intersection with 10th Avenue South. Southbound drivers have the signal at 10th in view for a block or two prior to their arrival at the 9th Ave. intersection. A good deal of their concentration is directed toward the signal while the location and operation requirements at the preceding intersection are all but ignored. Northbound traffic would have just passed through this major intersection to the south. Under certain circumstances, all of their concentration could be utilized to maneuver through that intersection and overload recovery may not have occurred upon their arrival at 9th Avenue. Recent studies related to driver behavior indicate that maximum loss of driving skills occurs immediately after a period of information overload and significant accident experience downstream of particularly complex intersections has been documented.

IMPROVEMENTS

There were 10 angle accidents and 3 rearend type accidents at this intersection. The accident rate is not as high as it could be, but some degree of caution is used by drivers entering 9th St. S. because the intersection actually appears to be dangerous from the side street. Most of the angle accidents involved drivers that had stopped prior to entering the intersection.

This would indicate that the highest priority improvement should be marking of parking restrictions by signing and curb painting. Oversize stop signs should be installed to assist drivers who would enter the intersection without stopping because the sign was not visible. The side street approach conditions should be improved by marking a short section of centerline preceding the stop bar. This will provide additional information to the driver upon approaching the intersection.

Because of high traffic volumes at this intersection a traffic signal warrant analysis was completed for this location. A summary of this analysis can be found at the end of this section. From the analysis, it appears that traffic signals are very close to being met at this intersection. At current levels of growth, signals may be warranted within the next five years.

Corridor recommendations to provide three traffic lanes which include a continuous left turn lane, would be especially applicable at this location for both now and when future signals are installed.

NINTH AVENUE S. & 9TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	13500
SOUTH APP	12700
EAST APP	2100
WEST APP	1300

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
WARNING	
GUIDANCE	

ESTIMATED COST:

TOTAL	\$1,620
MDoT FUND	\$880
CITY FUND	\$740

% ACCIDENT REDUCTION:

INJ/FTL	60%
PDO	52%

BENEFIT/COST RATIO:

53.45

	INDEX VALUE	SITE RANK
# ACCIDENTS	78	4
ACCIDENT RATE	24	24
SEVERITY	48	12
VOL/CAPACITY	84	4
SIGHT DIST.	100	1
DRIVER EXPECT	71	8
INFO DEFICIENT	67	11
HAZARD INDEX	59.7	4
B/C RATIO	86	4

PRIORITY	68.38	4
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TRAFFIC SIGNAL WARRANT ANALYSIS
YEAR 1991
NINTH AVE S. & 9TH ST. S., GREAT FALLS

WARRANT #1 - MINIMUM VEHICULAR VOLUME					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
		500	150	820	64
% OF WARRANT MET				164%	43%

WARRANT #2 - INTERRUPTION OF CONTINUOUS TRAFFIC					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
		750	75	820	64
% OF WARRANT MET				109%	85%

WARRANT #3 - MINIMUM PEDESTRIAN TRAFFIC					
50% WARRANT		REQUIRED		EXISTS	
YES	NO	PEDS	GAPS	PEDS	GAPS
		100	60	NA	NA
		190	60	NA	NA
% OF WARRANT MET				0%	ERR

WARRANT #4 - SCHOOL CROSSING [STUD	YES	NO
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WARRANT #5 - PROGRESSIVE MOVEMENT	YES	NO
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WARRANT #6 - ACCIDENT EXPERIENCE	YES	NO
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WARRANT #7 - SYSTEMS WARRANT	YES	NO
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WARRANT #8 - COMBINATION OF WARRANTS				
80 % OF WARRANTS #1 & #2	REQUIRED		EXISTS	
	MAJOR	MINOR	MAJOR	MINOR
WARRANT #1	400	120	820	64
WARRANT #2	600	60	820	64
% OF WARRANT MET			171%	80%

WARRANT #9 - FOUR HOUR VOLUMES				
	MAJOR	MINOR	CURVE NO.	WARRAN
4TH HIGHEST HOUR	1120	88	FIGURE	YES
NUMBER OF LANES	1	1	4.7	NO

WARRANT #10 - PEAK HOUR DELAY				
PEAK HOUR:	MINOR LEG		TOTAL ENTERING	
	DELAY	VOLUME	4 LEGS	3 LEGS
REQUIRED VALUES	4	100	800	650
EXISTING VALUES	1	100	1400	

WARRANT #11 - PEAK HOUR VOLUME				
	MAJOR	MINOR	CURVE NO.	WARRAN
PEAK HOUR	1250	100	FIGURE	YES
NUMBER OF LANES	1	1	4.5	NO

SUMMARY OF WARRANTS SATISFIED					
WARRANT 1		WARRANT 5		WARRANT 9	MARGIN
WARRANT 2		WARRANT 6		WARRANT 10	
WARRANT 3		WARRANT 7		WARRANT 11	MARGIN
WARRANT 4		WARRANT 8		TOTAL =	0

**SITE
NUMBER**

5

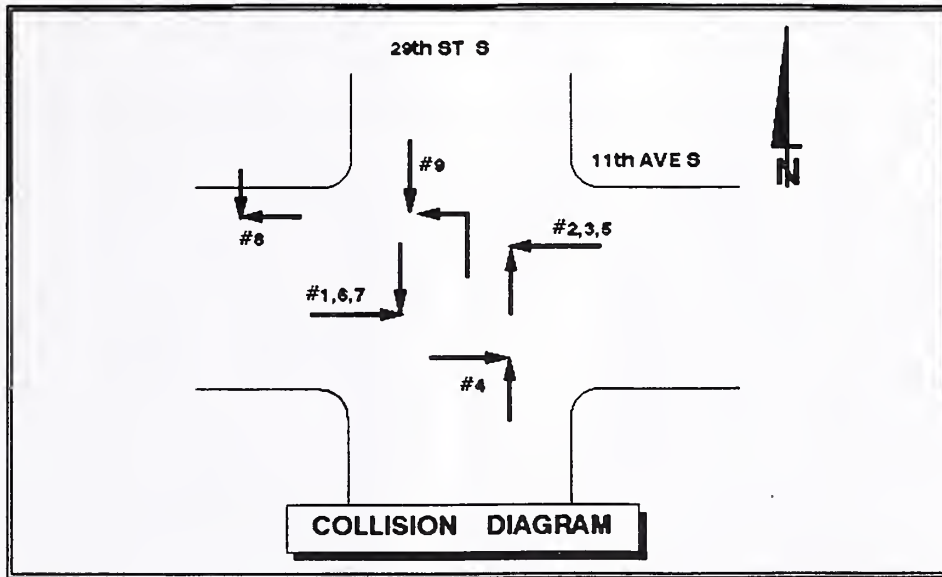
11TH AVENUE S.

and

29TH STREET S

ACCIDENT SUMMARY

ELEVENTH AVE S & 29TH STREET S

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
1	1988	NO. INJURY	1
2	1989	NO. FATAL	0
6	1990	NO. PDO	8
0	1991	Pers Inj = 2	
9	TOTAL	NIGHTTIME	0%

TYPES	NUMBER	ROAD	
ANGLE	8	DRY	78%
REAR END	0	WET	0%
SIDESWIPE	0	SNOW	11%
LEFT TRN	1	ICE	11%
OTHER	0	OTHER	0%



ELEVENTH AVENUE S, LOOKING EAST



ELEVENTH AVENUE S, LOOKING WEST



29TH STREET S, LOOKING NORTH



29TH STREET S, LOOKING SOUTH

TRAFFIC OPERATIONS

The area in which the intersection of 11th Avenue S. and 29th Street S. is located is obviously undergoing transition and growth. A new medical office complex is being built within the southwest quadrant of the intersection. Parking of construction workers vehicles and construction trailers had presented severe sight restrictions when traffic observations were being made. The City Technical Operations Supervisor was made aware of this condition immediately. The intersection area prior to construction of the adjacent building was in an open area with little if any roadside development.

There are stop signs located on 29th Street and a painted centerline on 11th Ave. South. Traffic volumes on 29th Street are roughly half those on 11th Avenue. The speed limit is 25 mph, but the 85% speed is in excess of 30 mph on 11th Avenue South. Turning movements at the intersection are relatively high which reduces capacity of 11th Ave. S. significantly. Unfortunately the 35' street widths are too narrow to develop or use left turn lanes at the intersection. The resulting congestion increases potential for accidents.

IMPROVEMENTS

There were 8 angle accidents and 1 left turn type accident at this intersection. All but three of the accidents occurred in 1990. This fact is not surprising since there has been a 25% increase in traffic between 1990 and 1991. The majority of angle accidents occurred because drivers on 26th Street did not stop for the stop signs. The remaining accidents were a result of inadequate sight distance. These conditions can be improved by installing oversized stop signs on 29th and providing rigid parking restrictions on the approaches. The clear zone required for sight distance, in this case, is in excess of those required on local streets because of higher speeds and narrower streets. Normal operating conditions can also be improved by providing appropriate pavement markings (centerlines and stop bars) on all approaches to provide drivers with visual clues to stop conditions and vehicle alignment.

Because of the degree of traffic growth at this intersection, the short term improvements may only retard an increase in accidents at this intersection. Significant improvements to this intersection and to the streets involved will be required within the near future if traffic continues to grow at the present rate. Because of high traffic volumes and growth, a traffic signal warrant analysis was completed for this intersection and can be found at the end of this section. Traffic signals are not currently warranted, but minimum volume warrants could easily be met when the new medical office building is occupied.

The most critical aspects of future traffic operations at this intersection and on the related streets is street width. The existing streets would have to be widened to a minimum of 40' to accommodate left turn lanes which are critical for capacity. The City of Great Falls should begin to address this problem as soon as possible.

ELEVENTH AVENUE S. & 29TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	2600
SOUTH APP	2900
EAST APP	5700
WEST APP	6200

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
WARNING	
GUIDANCE	YES

ESTIMATED COST:

TOTAL	\$2,300
MDOT FUND	\$1,480
CITY FUND	\$820

% ACCIDENT REDUCTION:

INJ/FTL	60%
PDO	53%

BENEFIT/COST RATIO:

19.46

	INDEX VALUE	SITE RANK
# ACCIDENTS	64	11
ACCIDENT RATE	26	21
SEVERITY	46	15
VOL/CAPACITY	91	1
SIGHT DIST.	100	7
DRIVER EXPECT	100	2
INFO DEFICIENT	83	3
HAZARD INDEX	64.2	1
B/C RATIO	64	11

PRIORITY	64.13	5
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**TRAFFIC SIGNAL WARRANT ANALYSIS
YEAR 1991
ELVENTH AVE S. & 29TH ST., GREAT FALLS**

WARRANT #1 - MINIMUM VEHICULAR VOLUME					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR		500	150	445	105
% OF WARRANT MET				89%	70%

WARRANT #2 - INTERRUPTION OF CONTINUOUS TRAFFIC					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR		750	75	445	105
% OF WARRANT MET				59%	140%

WARRANT #3 - MINIMUM PEDESTRIAN TRAFFIC					
50% WARRANT		REQUIRED		EXISTS	
YES	NO	PEDS	GAPS	PEDS	GAPS
FOUR HOURS		100	60	NA	NA
PEAK HOUR		190	60	NA	NA
% OF WARRANT MET				0%	ERR

WARRANT #4 - SCHOOL CROSSING [STUD	YES	NO
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WARRANT #5 - PROGRESSIVE MOVEMENT	YES	NO
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WARRANT #6 - ACCIDENT EXPERIENCE	YES	NO
----------------------------------	-----	----

WARRANT #7 - SYSTEMS WARRANT	YES	NO
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WARRANT #8 - COMBINATION OF WARRANTS				
80 % OF WARRANTS #1 & #2	REQUIRED		EXISTS	
	MAJOR	MINOR	MAJOR	MINOR
WARRANT #1	400	120	445	105
WARRANT #2	600	60	445	105
% OF WARRANT MET			93%	131%

WARRANT #9 - FOUR HOUR VOLUMES				
	MAJOR	MINOR	CURVE NO.	WARRAN
4TH HIGHEST HOUR	630	135	FIGURE	YES
NUMBER OF LANES	1	1	4.7	NO

WARRANT #10 - PEAK HOUR DELAY				
PEAK HOUR:	MINOR LEG		TOTAL ENTERING	
	DELAY	VOLUME	4 LEGS	3 LEGS
REQUIRED VALUES	4	100	800	650
EXISTING VALUES	0.8	120	950	

WARRANT #11 - PEAK HOUR VOLUME				
	MAJOR	MINOR	CURVE NO.	WARRAN
PEAK HOUR	700	120	FIGURE	YES
NUMBER OF LANES	1	1	4.5	NO

SUMMARY OF WARRANTS SATISFIED					
WARRANT 1		WARRANT 5		WARRANT 9	
WARRANT 2		WARRANT 6		WARRANT 10	
WARRANT 3		WARRANT 7		WARRANT 11	
WARRANT 4		WARRANT 8		TOTAL =	0

**SITE
NUMBER**

6

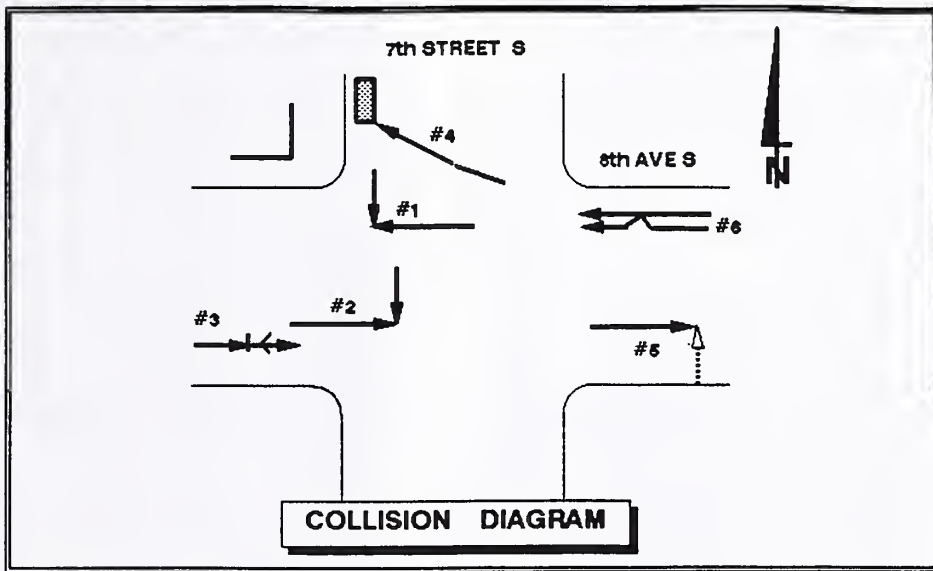
8TH AVENUE S.

and

7TH STREET S

ACCIDENT SUMMARY

8TH AVE. S & 7TH STREET S

[illegible]

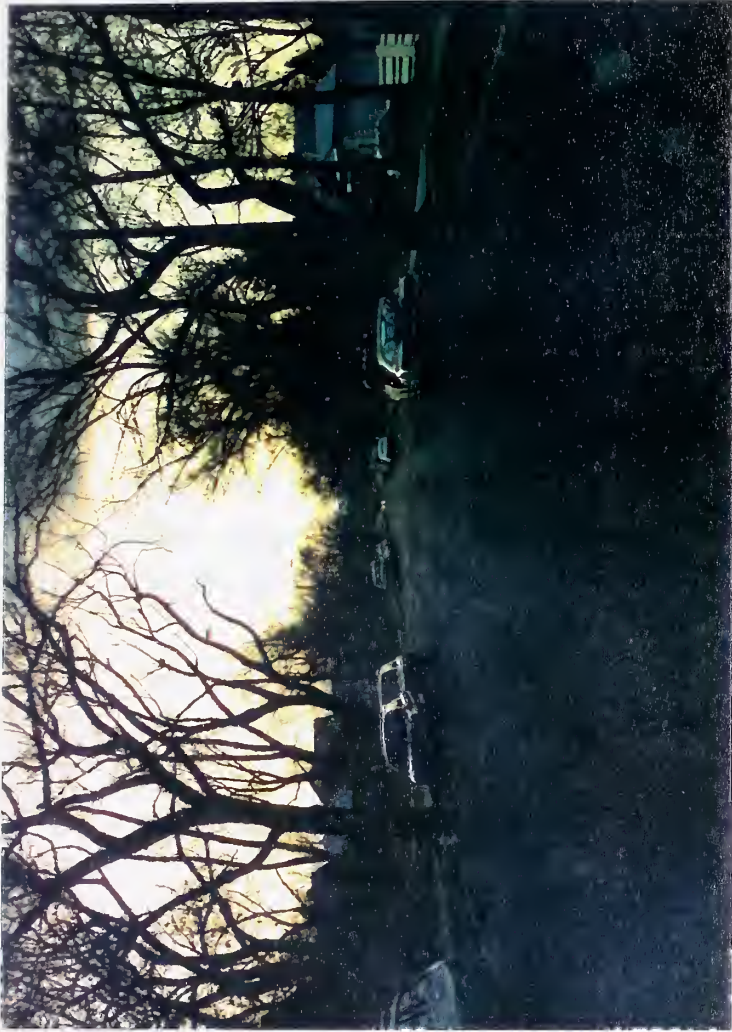
ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
2	1988	NO. INJURY	2
1	1989	NO. FATAL	0
3	1990	NO. PDO	4
0	1991	Pers Inj = 2	
6	TOTAL	NIGHTTIME	33%

TYPES	NUMBER	ROAD	
ANGLE	2	DRY	67%
REAR END	0	WET	0%
SIDESWIPE	1	SNOW	0%
PEDESTRIAN	1	ICE	33%
OTHER	2	OTHER	0%



EIGHT AVENUE S, LOOKING EAST



EIGHT AVENUE S, LOOKING WEST



7TH STREET S. LOOKING NORTH



7TH STREET S. LOOKING SOUTH

TRAFFIC OPERATIONS

The intersection of 8th Avenue S. and 7th Street S. is typical of most local intersections in the Great Falls urban area. There are no traffic control devices relative to the intersection and there are no street name signs. Traffic on 7th St. S. is slightly higher than on 8th Ave. South. There are no apparent sight restrictions other than tree trunks and parked vehicles. Eight Ave. was apparently reconstructed with new curb & gutter and paving in the recent past.

Problems at this intersection are relegated to mobile and intermittent sight restrictions which may cause partial blockage or blind spots in an approaching drivers view. The exact extent of this problem is difficult to state with any certainty because of the transient nature of the problem.

IMPROVEMENTS

Accident statistics at this intersection indicate that 2 of the six accidents were angle type. Thirty three percent of the accidents were on icy streets which indicates a marginally hazardous situation becomes more critical when stopping distance is increased. The other accidents at this intersection, including a pedestrian accident, all involve vehicles traveling along 8th Ave. South. In order to help alleviate this condition, it is recommended that yield signs be placed on the lower volume 8th Ave. S. approaches to slow at least one half of the approach traffic and increase the margin of safety. Curb restrictions at intersections should be reinforced by painting the curbs yellow. New street name signs will also contribute to safety of the intersection by eliminating navigation tasks from the drivers decision making duties.

EIGHT AVENUE S. & 7TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1000
SOUTH APP	1100
EAST APP	500
WEST APP	400

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	YES
STOP	
SIGNAL	
MARKING	
WARNING	
GUIDANCE	YES

ESTIMATED COST:

TOTAL	\$680
MDOT FUND	\$600
CITY FUND	\$80

% ACCIDENT REDUCTION:

INJ/FTL	35%
PDO	23%

BENEFIT/COST RATIO:

35.39

	INDEX VALUE	SITE RANK
# ACCIDENTS	54	19
ACCIDENT RATE	67	1
SEVERITY	49	9
VOL/CAPACITY	11	24
SIGHT DIST.	78	11
DRIVER EXPECT	67	11
INFO DEFICIENT	50	20
HAZARD INDEX	55.5	11
B/C RATIO	77	6

PRIORITY	62.6	6
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**SITE
NUMBER**

7

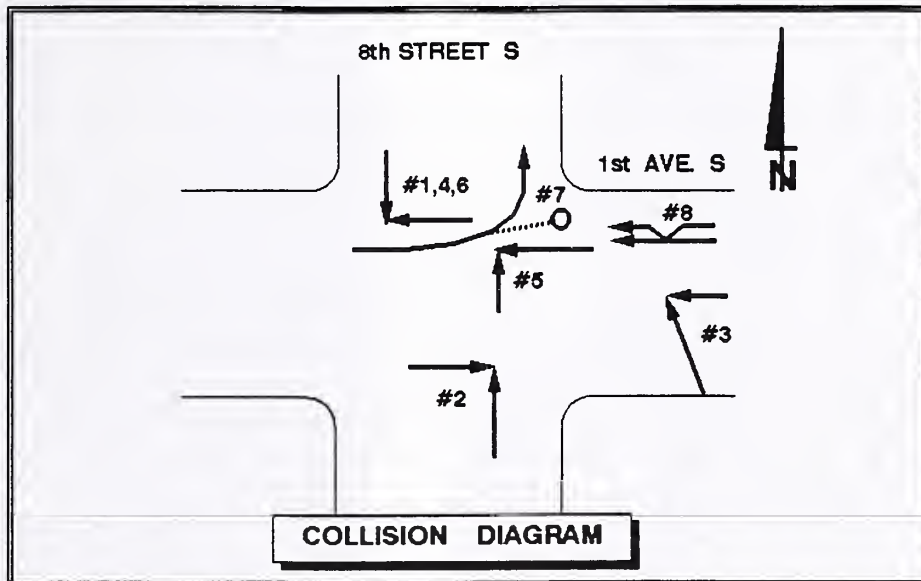
1ST AVENUE S.

and

8TH STREET S

ACCIDENT SUMMARY

FIRST AVE S & 8TH STREET S

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
1	1988	NO. INJURY	5
1	1989	NO. FATAL	0
4	1990	NO. PDO	3
2	1991	Pers Inj = 8	
8	TOTAL	NIGHTTIME	0%

TYPES	NUMBER	ROAD	
ANGLE	6	DRY	75%
REAR END	0	WET	13%
SIDESWIPE	1	SNOW	0%
LEFT TRN	0	ICE	13%
OTHER	1	OTHER	0%



FIRST AVENUE S, LOOKING EAST



FIRST AVENUE S, LOOKING EAST



8TH STREET S. LOOKING NORTH



8TH STREET S. LOOKING SOUTH

TRAFFIC OPERATIONS

First Avenue South is a one-way (westbound) street which traverses the CBD. It has three lanes with parking in a 52' width. Eight Street S. is a two-way street which is 52' wide north of 1st and 35' wide south of 1st. The most obvious problems at this intersection are the misalignment of the southbound thru lane from one side of the intersection to the other and infringement of parking lot vehicles into the corner sight triangle. Traffic approach speeds on 1st Ave. are in excess of 30 mph and lower on 8th Street South. Pavement markings are worn and it becomes difficult for drivers to be sure of proper driving alignment. Cross walks are present, but very little pedestrian traffic was observed.

IMPROVEMENTS

Six of the eight accidents at this site were angle accidents. Only one accident occurred on icy roads and it was a sideswipe accident. In order to improve accident experience at this intersection, it is recommended that increased parking restrictions in the northeast corner be implemented and the owner of the auto sales lot be contacted to arrange a method of keeping his cars out of the intersection sight triangle. Modifications to pavement markings should be made to move the southbound approach centerline to the west to line up with the centerline on the opposite side of the intersection. This action will increase southbound thru traffic's sight distance to the east and will improve required street crossing time to a slight degree. Other improvements are recommended to update one-way and turn restriction signing to the latest MUTCD standards.

FIRST AVENUE S. & 8TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	2300
SOUTH APP	2300
EAST APP	4600
WEST APP	5000

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
WARNING	
REGULATORY	YES

ESTIMATED COST:

TOTAL	\$3,420
MDOT FUND	\$780
CITY FUND	\$2,640

% ACCIDENT REDUCTION:

INJ/FTL	50%
PDO	25%

BENEFIT/COST RATIO:

38.57

	INDEX VALUE	SITE RANK
# ACCIDENTS	61	13
ACCIDENT RATE	28	20
SEVERITY	69	2
VOL/CAPACITY	50	12
SIGHT DIST.	100	4
DRIVER EXPECT	67	12
INFO DEFICIENT	33	25
HAZARD INDEX	54.5	12
B/C RATIO	79	5

PRIORITY	62.59	7
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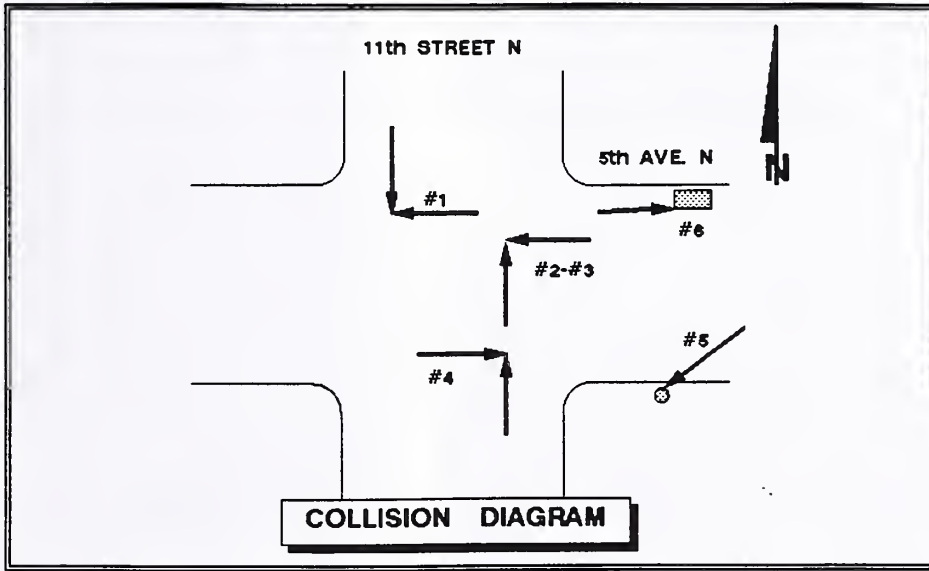
**SITE
NUMBER**

8

**5TH AVENUE N.
and
11TH STREET N.**

ACCIDENT SUMMARY

5TH AVENUE N & 11TH STREET N

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
1	1988	NO. INJURY	2
2	1989	NO. FATAL	0
3	1990	NO. PDO	4
0	1991	Pers Inj = 2	
6	TOTAL	NIGHTTIME	17%

TYPES	NUMBER	ROAD	
ANGLE	4	DRY	71%
REAR END	0	WET	14%
SIDESWIPE	0	SNOW	14%
PEDEST.	0	ICE	0%
OTHER	2	OTHER	0%



FIFTH AVENUE N, LOOKING EAST



FIFTH AVENUE N, LOOKING WEST



11TH STREET N, LOOKING NORTH



11TH STREET N, LOOKING SOUTH

TRAFFIC OPERATIONS

The intersection of 5th Avenue N. and 11th Street N. is one of two sites located north of Central Avenue. The intersection is located in an older residential section of town. The streets have boulevards with mature trees and thick trunks. There are no traffic control devices relative to intersection operation. Traffic on both intersecting streets are approximately equal and well within normal limits of local residential streets. There are no apparent sight restrictions other than tree trunks and parked vehicles.

Problems at this intersection are relegated to mobile and intermittent sight restrictions which may cause partial blockage or blind spots in an approaching drivers view. The exact extent of this problem is difficult to state with any certainty because of the transient nature of the problem.

IMPROVEMENTS

Accident statistics at this intersection indicate that 4 of the six accidents were angle type. No particular combination of directional movements were prominent in these accidents. Almost all of the accidents were on dry roads in daylight conditions. In order to help alleviate probably sight restrictions, it is recommended that no parking signs be installed and curbs painted yellow to enforce corner parking restrictions. Added reinforcement provided by the signs is considered necessary because of the number of apartment buildings and high potential demand for on-street parking.

FIFTH AVENUE N. & 11TH STREET N.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	700
SOUTH APP	600
EAST APP	900
WEST APP	900

EXISTING CONTROL:

NONE	YES
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	
SIGNAL	
MARKING	
WARNING	
REGULATORY	

ESTIMATED COST:

TOTAL	\$880
MDoT FUND	\$800
CITY FUND	\$80

% ACCIDENT REDUCTION:

INJ/FTL	40%
PDO	20%

BENEFIT/COST RATIO:

30.88

	INDEX VALUE	SITE RANK
# ACCIDENTS	54	21
ACCIDENT RATE	67	2
SEVERITY	49	10
VOL/CAPACITY	23	19
SIGHT DIST.	68	14
DRIVER EXPECT	67	15
INFO DEFICIENT	50	22
HAZARD INDEX	55.7	9
B/C RATIO	74	7

PRIORITY	61.74	8
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**SITE
NUMBER**

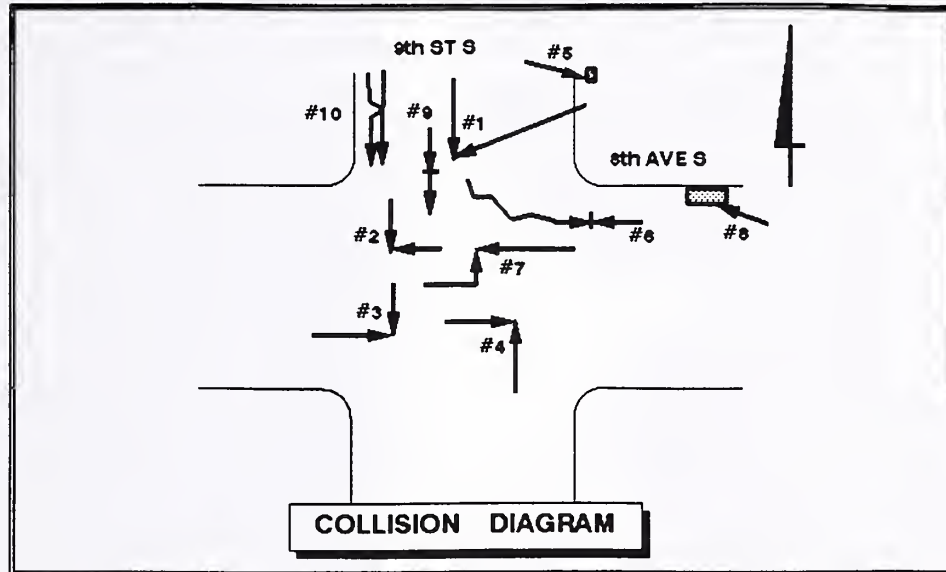
9

8TH AVENUE S.

and

9TH STREET S

ACCIDENT SUMMARY EIGHT AVE S & 9TH STREET S



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	4	1	88	1312	PROP DAM	CLEAR	DRY	DAY
2	ANGLE	12	29	89	1024	INJURY	CLEAR	ICY	DAY
3	ANGLE	9	1	90	1259	INJURY	CLEAR	DRY	DAY
4	ANGLE	9	12	90	1706	PROP DAM	CLEAR	DRY	DAY
5	FIXED OBJ	8	16	89	2340	PROP DAM	CLEAR	DRY	NITE
6	HEAD ON	6	10	88	115	PROP DAM	CLEAR	DRY	NITE
7	LEFT TURN	4	12	88	1540	INJURY	CLEAR	DRY	DAY
8	PARKED CAR	1	31	89	1343	PROP DAM	CLEAR	SNOW	DAY
9	REAREND	11	30	89	1421	INJURY	CLEAR	DRY	DAY
10	SIDESWIPE	6	13	90	1114	PROP DAM	RAIN	WET	DAY

ACCIDENT STATISTICS

NO.				TYPES	NUMBER	ROAD	
ACC.	YEAR			ANGLE	4	DRY	70%
3	1988	NO. INJURY	4	REAR END	1	WET	10%
4	1989	NO. FATAL	0	SIDESWIPE	1	SNOW	10%
3	1990	NO. PDO	6	LEFT TRN	1	ICE	10%
0	1991	Pers Inj = 4		OTHER	3	OTHER	0%
10	TOTAL	NIGHTTIME	20%				



EIGHT AVENUE S, LOOKING EAST



EIGHT AVENUE S, LOOKING WEST



9TH STREET S, LOOKING NORTH



9TH STREET S, LOOKING SOUTH

TRAFFIC OPERATIONS

The intersection of 8th Avenue S. And 9th Street S. is similar to the intersection immediately south on Ninth St. S. at 9th Avenue, except for fewer turning movements and lower volumes on the 8th Ave. side street approaches. Left turns from southbound traffic are the only significant turning movements at this location. Obvious operational problems noted at this intersection are higher speeds on 9th St. S., and lack of adequate parking control. Increasing traffic volumes at this intersection will undoubtedly magnify the current accident problem.

The proximity of 8th Avenue's intersection with 10th Avenue South has some influence on driver behavior at this intersection, but not to the same extent as at 9th Avenue. The existence of a drive-thru window for a credit union in the northeast corner of the intersection plays a factor in traffic operations at this location. However, traffic generated by the credit union is fairly low and does not significantly influence safety and efficiency of the intersection.

IMPROVEMENTS

There were 4 angle accidents and 6 other varied accidents at this location. None of the accidents involved drivers running the side street stop signs. This would indicate that the highest priority improvement should be marking of parking restrictions by signing and curb painting. The side street approach conditions should be improved by marking a short section of centerline preceding a new stop bar. This will provide additional information to the driver upon approaching the intersection and will help drivers align their vehicles appropriately.

Because of low traffic volumes on the side street, a traffic signal warrant analysis was not completed for this location.

Corridor recommendations to provide three traffic lanes which include a continuous left turn lane, would be applicable at this location because of higher volumes of southbound left turns.

EIGHT AVENUE S. & 9TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	12600
SOUTH APP	12300
EAST APP	1300
WEST APP	800

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
WARNING	
REGULATORY	

ESTIMATED COST:

TOTAL	\$2,040
MDOT FUND	\$800
CITY FUND	\$1,240

% ACCIDENT REDUCTION:

INJ/FTL	33%
PDO	22%

BENEFIT/COST RATIO:

21.98

	INDEX VALUE	SITE RANK
# ACCIDENTS	67	10
ACCIDENT RATE	18	25
SEVERITY	51	7
VOL/CAPACITY	84	5
SIGHT DIST.	100	5
DRIVER EXPECT	79	5
INFO DEFICIENT	67	12
HAZARD INDEX	58.3	5
B/C RATIO	67	10

PRIORITY	61.17	9
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**SITE
NUMBER**

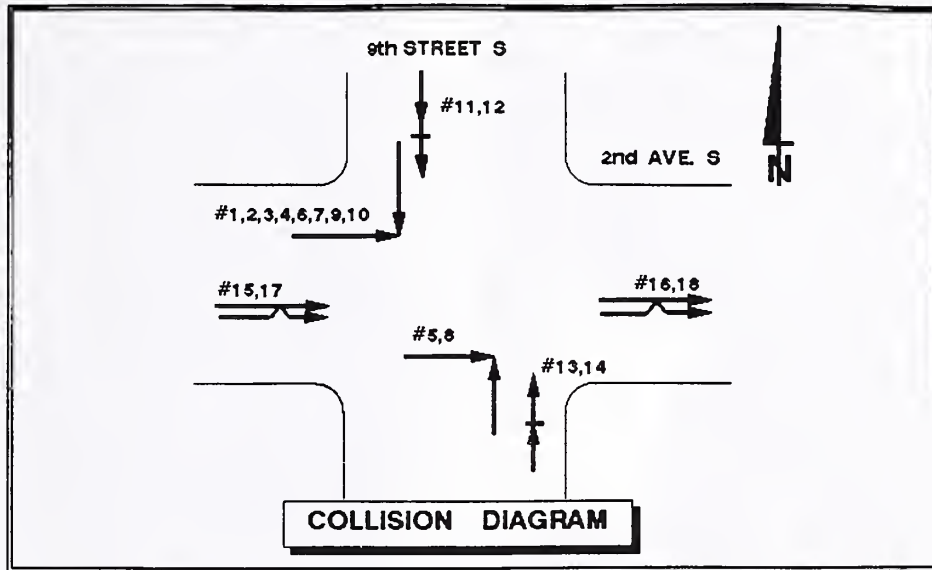
10

2ND AVENUE S.

and

9TH STREET S

ACCIDENT SUMMARY 2ND AVENUE S & 9TH STREET S



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	12	24	88	1418	PROP DAM	SNOW	SNOW	DAY
2	ANGLE	1	9	89	1745	PROP DAM	CLEAR	ICY	NITE
3	ANGLE	2	19	89	1625	PROP DAM	CLEAR	SNOW	DAY
4	ANGLE	5	13	89	1148	INJURY	RAIN	WET	DAY
5	ANGLE	2	15	90	1325	PROP DAM	CLEAR	ICY	DAY
6	ANGLE	8	22	90	1620	INJURY	CLEAR	DRY	DAY
7	ANGLE	9	2	90	548	INJURY	CLEAR	DRY	NITE
8	ANGLE	9	10	90	917	INJURY	CLEAR	DRY	DAY
9	ANGLE	11	29	90	1519	PROP DAM	CLEAR	DRY	DAY
10	ANGLE	2	23	91	2317	PROP DAM	CLEAR	DRY	NITE
11	REAREND	3	29	88	927	INJURY	CLEAR	DRY	DAY
12	REAREND	5	6	88	1449	PROP DAM	RAIN	WET	DAY
13	REAREND	12	20	88	1318	INJURY	CLEAR	DRY	DAY
14	REAREND	10	22	90	1232	PROP DAM	CLEAR	DRY	DAY
15	SIDESWIPE	4	19	88	1744	PROP DAM	CLEAR	DRY	DAY
16	SIDESWIPE	10	29	88	126	PROP DAM	CLEAR	DRY	NITE
17	SIDESWIPE	6	29	90	1902	PROP DAM	CLEAR	DRY	DAY
18	SIDESWIPE	1	16	91	1105	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO.	ACC.	YEAR		
6	1988		NO. INJURY	6
3	1989		NO. FATAL	0
7	1990		NO. PDO	12
2	1991		Pers Inj = 7	
18	TOTAL		NIGHTTIME	22%

TYPES	NUMBER	ROAD	
ANGLE	10	DRY	60%
REAR END	4	WET	11%
SIDESWIPE	4	SNOW	14%
PEDEST.	0	ICE	14%
OTHER	0	OTHER	0%



SECOND AVENUE S, LOOKING EAST



9TH STREET S, LOOKING SOUTH



9TH STREET S, LOOKING NORTH



9TH STREET S, LOOKING NORTH

TRAFFIC OPERATIONS

The intersection of 2nd Avenue S. and 9th Street S. is a signalized intersection. Second Avenue S. is a one-way (eastbound) street that carries traffic from the CBD area to the residential areas on the eastside of Great Falls. Some of the initial observations at this intersection indicated the following:

Second Avenue South seems much too narrow to carry 2 higher speed lanes of traffic with parking on both sides.

The combination of tree lined boulevards, a narrow street and parking on 2nd tends to narrow the drivers focus to the street surface rather than the horizon.

The advance lane control signs for the southbound approach tends to overshadow the signal indications and requires a driver to direct his attention to two separate locations.

Yellow clearance intervals on the signal are only 2.5 to 3.0 seconds. The last car in at least 50% of the vehicle queues enter the intersection on a red.

Lane control on the 2nd Avenue approach is not clear, even when a driver is at the intersection. It is not evident which way a vehicle can turn or proceed.

There is a tremendous amount of drive approach activity near the intersection which diverts a drivers attention.

There are no turn prohibition signs even though it is an intersection with a one-way street.

IMPROVEMENTS

There were 10 angle accidents, 4 rearend and four sideswipe accidents at this location. Most of the angle accidents involved drivers running a red light. This fact and the presence of rearend accidents provides an indication that

clearance interval timing and signal visibility may be prime candidates for improvement. The speed limit on both streets is 30 mph. The 85th % speed is probably somewhat higher. Because of speeds and accident experience the signal should be retimed to allow 4.0 seconds yellow and 1.0 seconds all-red. Counts should also be taken at various times of the day to verify approach green times. It may be necessary to sacrifice some efficiency to improve safety. However, capacity calculations indicate a good level-of-service with existing green times. Increasing the clearance interval will not decrease capacity to any significant degree.

Use of a 12"x8"x8" signal indication has been widely accepted within the past ten to twenty years. Rarely is a 12"x12"x12" indication used. There is much controversy over the need for a straight 12" signal head and thus far no statistics are available to support claims either way. A logical examination of their use may shed more light on the subject. A 12" red lense only serves those drivers who have already seen the yellow; those who are already stopped; and those who are approaching and are anticipating the change to red. Twelve inch green lenses improve visibility for those who are approaching the signal by alerting them to the presence of a signal; providing information which can be used to calculate desired speed; and alerting them to the potential for change. The twelve inch yellow improves visibility for approaching drivers and serves to alert them that the red stop condition is imminent and allows them to decide the proper course of action. When these facts are considered, use of a 12" red lense for improved visibility is not nearly as important as use of 12" yellow and green lenses. As far as driver perception and reaction is concerned, need for the red lense is always after the fact. In other words, when the red lense is illuminated, it is too late for any safe action other than to remain stopped. It is therefore recommended that mast arm signal indications should be changed to a 12"x12"x12" type.

Another important consideration at this intersection concerns sideswipe accidents that occur on the eastbound approach. It is felt that these accidents occur because of the lack of information regarding lane assignments. Pavement markings and advanced signing should be installed to properly inform drivers of required lane change and allowable movements. One-way street sign and turn prohibitions should be installed according to MUTCD guidelines. This will help prevent wrong way movements and reinforce proper lane control provisions. In addition, parking restrictions should be posted on 2nd Ave. at the intersection approaches to open up the existing constriction.

SECOND AVENUE S. & 9TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	9700
SOUTH APP	10400
EAST APP	3500
WEST APP	5300

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	YES

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	
SIGNAL	YES
MARKING	YES
GUIDANCE	YES
REGULATORY	YES

ESTIMATED COST:

TOTAL	\$4,130
MDOT FUND	\$2,000
CITY FUND	\$2,130

% ACCIDENT REDUCTION:

INJ/FTL	43%
PDO	45%

BENEFIT/COST RATIO:

30.4

	INDEX VALUE	SITE RANK
# ACCIDENTS	82	2
ACCIDENT RATE	24	23
SEVERITY	51	6
VOL/CAPACITY	87	3
SIGHT DIST.	28	22
DRIVER EXPECT	67	16
INFO DEFICIENT	56	16
HAZARD INDEX	54	15
B/C RATIO	74	8

PRIORITY	60.6	10
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**SITE
NUMBER**

1 1

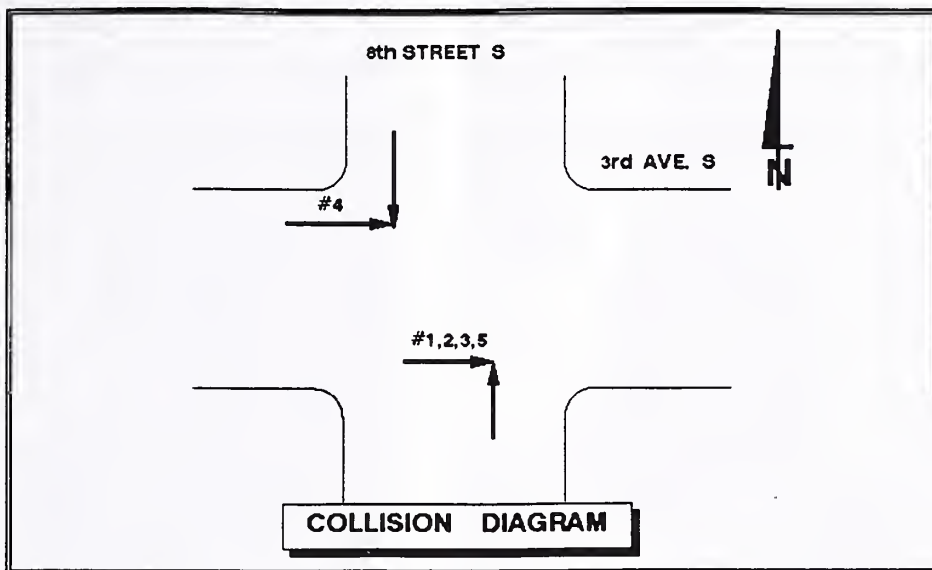
3RD AVENUE S.

and

8TH STREET S.

ACCIDENT SUMMARY

3RD AVENUE S & 8TH STREET S

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
2	1988	NO. INJURY	1
1	1989	NO. FATAL	0
2	1990	NO. PDO	4
0	1991	Pers Inj = 1	
5	TOTAL	NIGHTTIME	20%

TYPES	NUMBER	ROAD	
ANGLE	5	DRY	60%
REAR END	0	WET	0%
SIDESWIPE	0	SNOW	0%
PEDEST.	0	ICE	40%
OTHER	0	OTHER	0%



THIRD AVENUE S, LOOKING WEST



8TH STREET S, LOOKING SOUTH



THIRD AVENUE S, LOOKING EAST



8TH STREET S, LOOKING NORTH

TRAFFIC OPERATIONS

The intersection of 3rd Avenue S. and 8th Street S. is located within a residential neighborhood. There is a neighborhood grocery located in the southeast corner and a small cafe in the southwest corner of this intersection. Both of these businesses generate a small amount of parking and vehicular activity. There are no permanent site restriction at this local street intersection. Traffic volumes on both streets relatively low. The only potential problems would be vehicles, especially delivery vehicles, parked near the intersection. Since, almost all of the accidents occurred at 11-12 AM and 1-2 PM, the evidence points to a temporary or intermittent sight restriction.

IMPROVEMENTS

All of the accidents at this intersection were angle type. All but one were in the southwest quadrant of the intersection. In order to help alleviate probable sight restrictions, it is recommended that no parking signs be installed and curbs painted yellow to enforce corner parking restrictions in the southwest corner. Curbs should painted yellow in all other quadrants. Removing hidden street name signs that currently exist and installing new signs at a new location will also reduce drivers navigation requirements.

THIRD AVENUE S. & 8TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	700
SOUTH APP	500
EAST APP	900
WEST APP	800

EXISTING CONTROL:

NONE	YES
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	
SIGNAL	
MARKING	
GUIDANCE	YES
REGULATORY	

ESTIMATED COST:

TOTAL	\$700
MDOT FUND	\$600
CITY FUND	\$100

% ACCIDENT REDUCTION:

INJ/FTL	50%
PDO	50%

BENEFIT/COST RATIO:

27.09

	INDEX VALUE	SITE RANK
# ACCIDENTS	50	25
ACCIDENT RATE	55	6
SEVERITY	44	16
VOL/CAPACITY	18	21
SIGHT DIST.	59	16
DRIVER EXPECT	67	14
INFO DEFICIENT	67	14
HAZARD INDEX	52.3	19
B/C RATIO	72	9

PRIORITY	58.8	11
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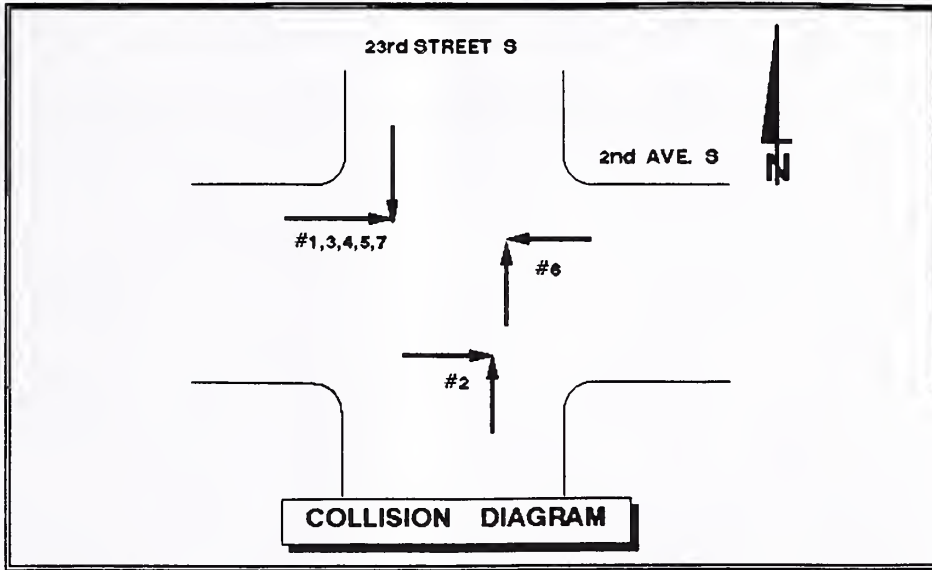
**SITE
NUMBER**

12

**2ND AVENUE S.
and
23RD STREET S.**

ACCIDENT SUMMARY

2ND AVENUE S & 23RD STREET S

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
4	1988	NO. INJURY	3
3	1989	NO. FATAL	0
0	1990	NO. PDO	4
0	1991	Pers Inj = 3	
7	TOTAL	NIGHTTIME	0%

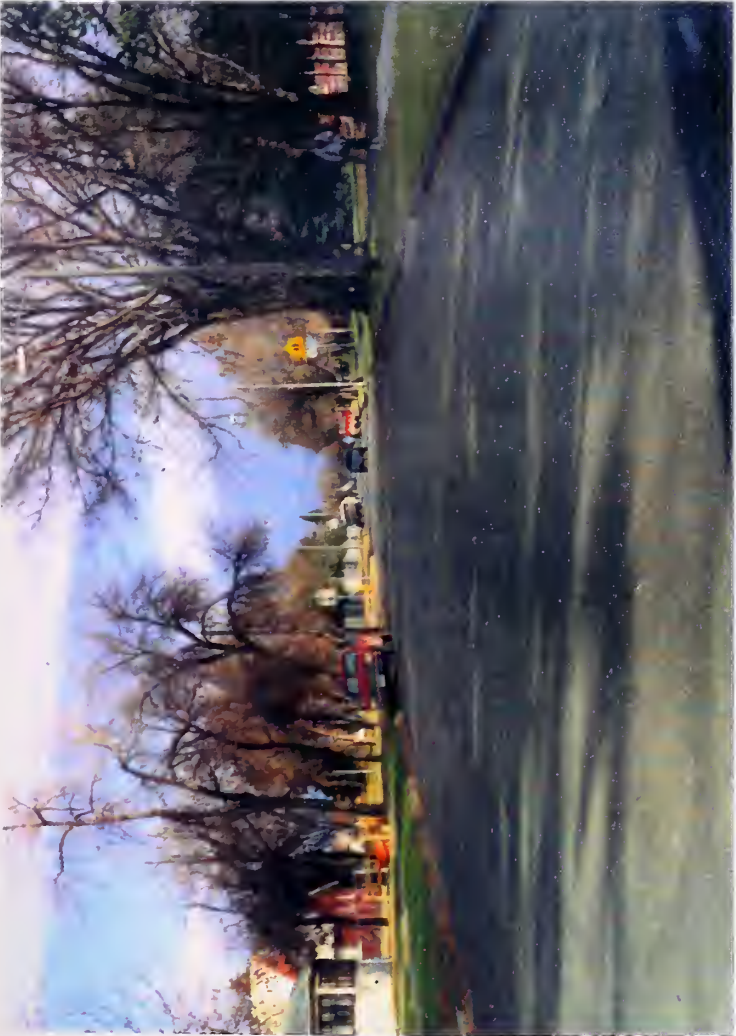
TYPES	NUMBER	ROAD	
ANGLE	7	DRY	29%
REAR END	0	WET	14%
SIDESWIPE	0	SNOW	14%
PEDEST.	0	ICE	43%
OTHER	0	OTHER	0%



SECOND AVENUE S, LOOKING WEST



23RD STREET S, LOOKING SOUTH



SECOND AVENUE S, LOOKING EAST



23RD STREET S, LOOKING NORTH

TRAFFIC OPERATIONS

The intersection of 2nd Avenue S. and 23rd Street S. is located within a residential neighborhood. There is a school in the northeast quadrant of the intersection. Proper school crossing and yield signs control the intersection. There are significant numbers of school age pedestrians that cross at this intersection. Traffic volumes are low with slightly more traffic on 23rd than on 2nd. The school crossing on the westbound approach has a no parking sign 20' from the beginning curb radius, but it is extremely faded. The yield signs appear to be washed out and unobtrusive depending on the angle of sight.

IMPROVEMENTS

All of the accidents at this intersection were angle type. All but two were in the northwest quadrant of the intersection. All of the accidents occurred prior to 1990 and because of this fact, it is suspected that the yield signs may have been installed at the end of 1989 and significant improvements have already been realized. In any case, certain improvements should be made to further reduce the potential for accidents. It is recommended that the faded parking and yield signs be replaced. A short section of centerline should be painted to the stop bar to increase drivers awareness of potential conflicts. Restriping the crosswalks to the recommended standard 2'x8' lateral marks will improve visibility by a factor of 60. Curbs should be painted yellow in all intersection quadrants.

SECOND AVENUE S. & 23RD STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1300
SOUTH APP	1000
EAST APP	900
WEST APP	800

EXISTING CONTROL:

NONE	
YIELD	YES
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	YES
STOP	
SIGNAL	
MARKING	YES
GUIDANCE	
REGULATORY	

ESTIMATED COST:

TOTAL	\$1,090
MDoT FUND	\$400
CITY FUND	\$690

% ACCIDENT REDUCTION:

INJ/FTL	20%
PDO	16%

BENEFIT/COST RATIO:

18.94

	INDEX VALUE	SITE RANK
# ACCIDENTS	58	16
ACCIDENT RATE	60	5
SEVERITY	52	5
VOL/CAPACITY	24	18
SIGHT DIST.	59	17
DRIVER EXPECT	67	23
INFO DEFICIENT	46	23
HAZARD INDEX	54.3	14
B/C RATIO	64	13

PRIORITY	57.5	12
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**SITE
NUMBER**

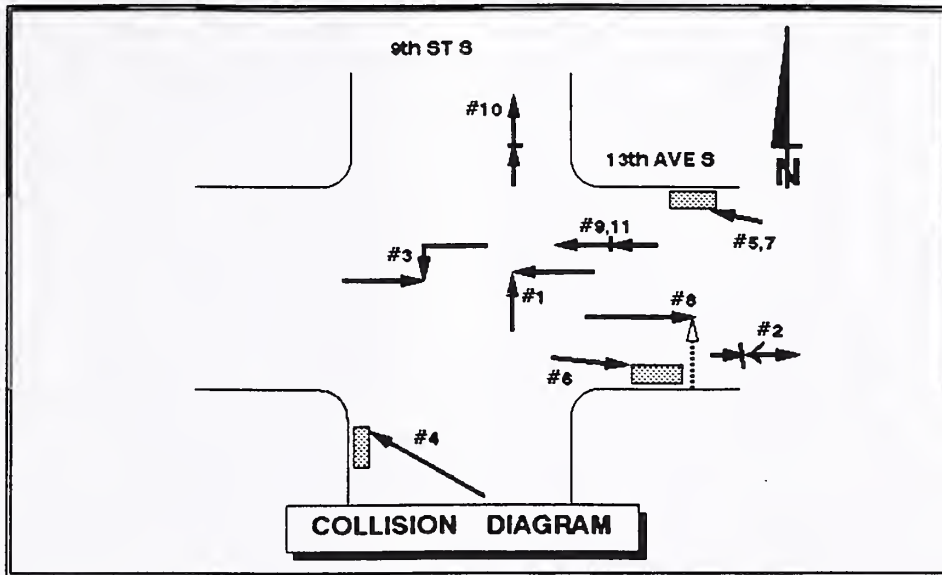
13

13TH AVENUE S.

and

9TH STREET S.

ACCIDENT SUMMARY THIRTEENTH AVE S & 9TH STREET S



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	12	18	89	1151	PROP DAM	CLEAR	DRY	DAY
2	BACKING	3	16	90	1706	PROP DAM	CLEAR	DRY	NITE
3	LEFT TURN	12	17	88	1404	PROP DAM	CLEAR	WET	DAY
4	PARKED CAR	12	19	88	2059	PROP DAM	SNOW	ICY	NITE
5	PARKED CAR	12	1	89	25	PROP DAM	CLEAR	DRY	NITE
6	PARKED CAR	8	6	90	2236	PROP DAM	CLEAR	DRY	NITE
7	PARKED CAR	9	28	90	2232	PROP DAM	CLEAR	DRY	NITE
8	PEDESTRIAN	1	26	90	1445	INJURY	CLEAR	SNOW	DAY
9	REAREND	11	17	88	2250	PROP DAM	SNOW	ICY	NITE
10	REAREND	7	26	89	2248	PROP DAM	RAIN	WET	NITE
11	REAREND	8	24	89	1252	PROP DAM	RAIN	WET	DAY

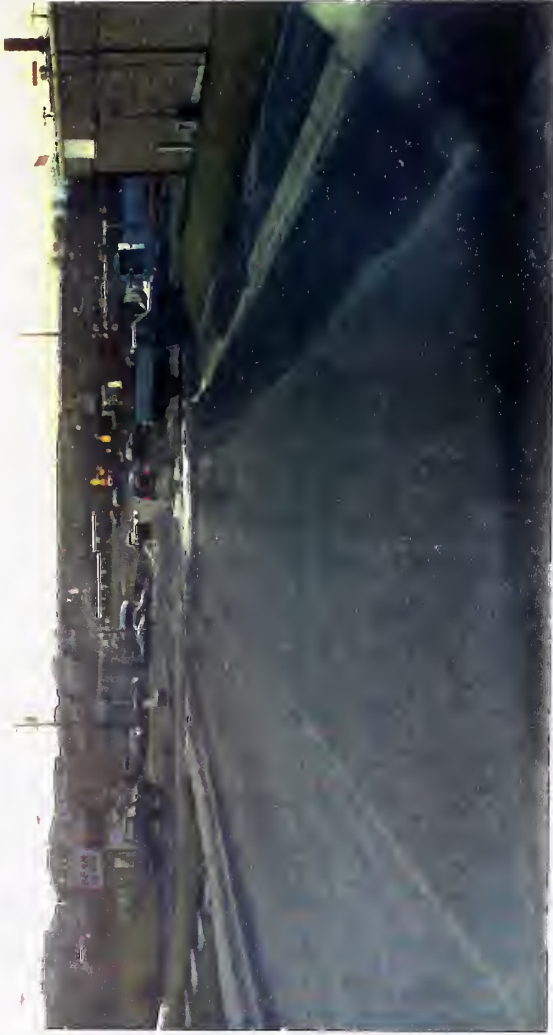
ACCIDENT STATISTICS

NO.	ACC.	YEAR		
3	1988	NO. INJURY	1	
4	1989	NO. FATAL	0	
4	1990	NO. PDO	10	
0	1991	Pers Inj = 1		
11	TOTAL	NIGHTTIME	58%	

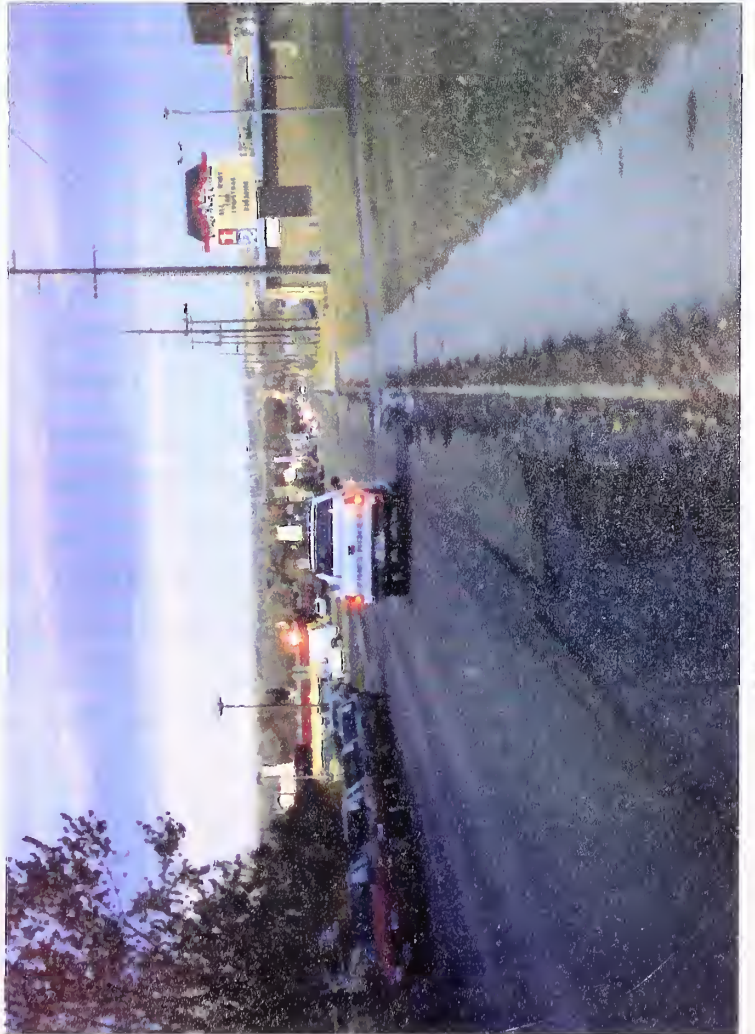
TYPES	NUMBER	ROAD	
ANGLE	1	DRY	67%
REAR END	3	WET	17%
SIDESWIPE	0	SNOW	17%
LEFT TRN	1	ICE	0%
PEDESTRIAN	1	OTHER	0%
OTHER	5		



THIRTEEN AVENUE S, LOOKING EAST



THIRTEENTH AVENUE S, LOOKING WEST



9TH STREET S, LOOKING NORTH



9TH STREET S, LOOKING SOUTH

TRAFFIC OPERATIONS

The intersection of 13th Avenue S. and 9th Street S. is one of several intersections within the confines of this study which is experiencing traffic growth on the south end of Great Falls. Land use adjacent to this intersection is primarily commercial. A movie theater which generates a significant volume of traffic during evening and night time hours, is located in the southeast quadrant of the intersection. The most striking observations at this intersection were the steep grades approaching the intersection from the east and from the south; the combination of narrow (35') streets, high volumes and parking on all streets sections; high percentage turning movements at the intersection; and an inappropriate speed zone (25 mph). Ninth Street S. in this area must be a source of revenue for the Police Department, because a police car was using radar south of the site on every site traffic observation conducted. Vehicle speeds in the northbound direction are naturally higher because of the extended downgrade and relatively undeveloped land south of the intersection.

There appears to be relatively little on-street parking demand during the daytime hours. Parking signs and curb paint restricts parking north of the intersection area, but there are no similar restrictions south of the intersection.

IMPROVEMENTS

Accident types experienced at this intersection are varied. Of the eleven accidents reported the majority involved parked cars (4). Rearend collisions (3) were the next most common. There was only one angle accident resulting from failure to stop. Recommendations with regard to this intersection are made for a short term situation. Delineation of new parking restrictions south of the intersection on 9th and on both 13th approaches along with reinforced restrictions north of the intersection will aid sight distance and eliminate parked car accidents. Installation of an oversize stop sign on the westbound approach along with a stop ahead sign will reduce rear end and angle accidents by providing more time for drivers to prepare for a stop on the downgrade. Striping of centerlines and stop bars on 13th will provide

additional indications of the impending intersection and aid in vehicle guidance. Street name signs will also reduce drivers navigational requirements.

It is also recommended that an engineering study be completed on 9th Street South to determine the proper speed zone. Inadequate speed zoning and speed traps in an area where it requires a conscious efforts to maintain a slow speed can do more harm by adding to the drivers work load than the benefits of traveling at a lower speed.

Because of the higher traffic volumes and turning movements at this intersection, a traffic signal warrant analysis was completed. The warrant summary can be found at the end of this section. None of the eleven signal warrants were met at this location even though peak hour delay is approaching warrant values. Future volumes at this intersection may require installation on left turn lanes in lieu of a traffic signal, since installation of a signal at the end of extended grades can be inherently dangerous. However, the existing street width is too narrow to adequately accommodate three traffic lanes. For this reason, the City of Great Falls should begin exploring options for future improvements at this intersection and on the streets involved.

THIRTEENTH AVENUE S. & 9TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	4800
SOUTH APP	3700
EAST APP	3400
WEST APP	3100

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
GUIDANCE	YES
WARNING	YES

ESTIMATED COST:

TOTAL	\$1,760
MDOT FUND	\$1,080
CITY FUND	\$680

% ACCIDENT REDUCTION:

INJ/FTL	20%
PDO	19%

BENEFIT/COST RATIO:

5.13

	INDEX VALUE	SITE RANK
# ACCIDENTS	69	9
ACCIDENT RATE	31	16
SEVERITY	39	21
VOL/CAPACITY	91	2
SIGHT DIST.	100	8
DRIVER EXPECT	100	1
INFO DEFICIENT	75	5
HAZARD INDEX	63.9	2
B/C RATIO	36	20

PRIORITY	54.69	13
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TRAFFIC SIGNAL WARRANT ANALYSIS
YEAR 1991
THIRTEENTH AVE S & 9TH ST. S, GREAT FALL

WARRANT #1 - MINIMUM VEHICULAR VOLUME					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR		500	150	315	144
% OF WARRANT MET				63%	96%

WARRANT #2 - INTERRUPTION OF CONTINUOUS TRAFFIC					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR		750	75	315	144
% OF WARRANT MET				42%	192%

WARRANT #3 - MINIMUM PEDESTRIAN TRAFFIC					
50% WARRANT		REQUIRED		EXISTS	
YES	NO	PEDS	GAPS	PEDS	GAPS
FOUR HOURS		100	60	NA	NA
PEAK HOUR		190	60	NA	NA
% OF WARRANT MET				0%	ERR

WARRANT #4 - SCHOOL CROSSING [STUD YES NO

WARRANT #5 - PROGRESSIVE MOVEMENT YES NO

WARRANT #6 - ACCIDENT EXPERIENCE YES NO

WARRANT #7 - SYSTEMS WARRANT YES NO

WARRANT #8 - COMBINATION OF WARRANTS				
80 % OF WARRANTS #1 & #2	REQUIRED		EXISTS	
	MAJOR	MINOR	MAJOR	MINOR
WARRANT #1	400	120	315	144
WARRANT #2	600	60	315	144
% OF WARRANT MET			66%	180%

WARRANT #9 - FOUR HOUR VOLUMES				
	MAJOR	MINOR	CURVE NO.	WARRAN
4TH HIGHEST HOUR	410	185	FIGURE	YES
NUMBER OF LANES	1	1	4.7	NO

WARRANT #10 - PEAK HOUR DELAY				
PEAK HOUR:	MINOR LEG		TOTAL ENTERING	
	DELAY	VOLUME	4 LEGS	3 LEGS
REQUIRED VALUES	4	220	800	650
EXISTING VALUES	2	240	750	

WARRANT #11 - PEAK HOUR VOLUME				
	MAJOR	MINOR	CURVE NO.	WARRAN
PEAK HOUR	480	220	FIGURE	YES
NUMBER OF LANES	1	1	4.5	NO

SUMMARY OF WARRANTS SATISFIED					
WARRANT 1		WARRANT 5		WARRANT 9	
WARRANT 2		WARRANT 6		WARRANT 10	
WARRANT 3		WARRANT 7		WARRANT 11	
WARRANT 4		WARRANT 8		TOTAL =	0

**SITE
NUMBER**

14

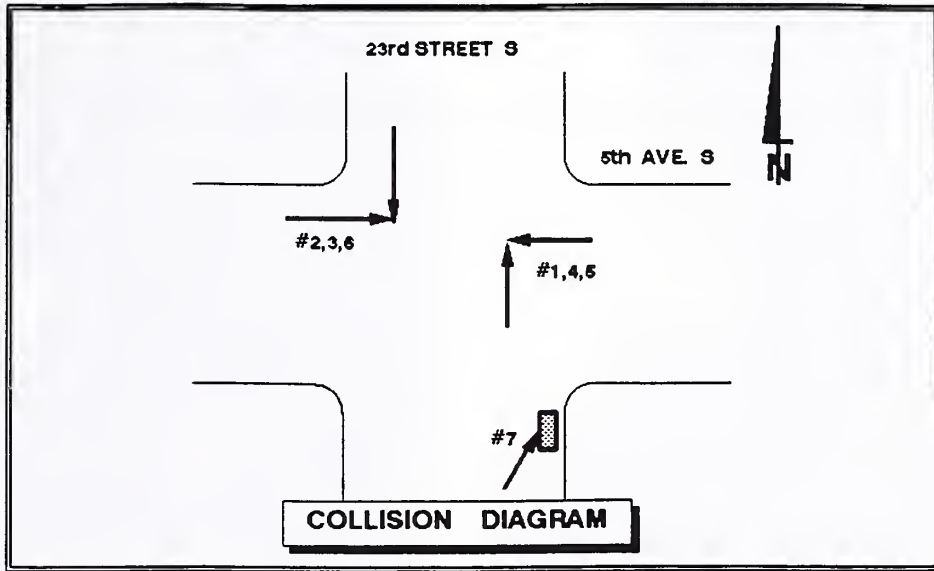
5TH AVENUE S.

and

23RD STREET S

ACCIDENT SUMMARY

5TH AVENUE S & 23RD STREET S

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
0	1988	NO. INJURY	0
1	1989	NO. FATAL	0
6	1990	NO. PDO	7
0	1991	Pers Inj = 0	
7	TOTAL	NIGHTTIME	0%

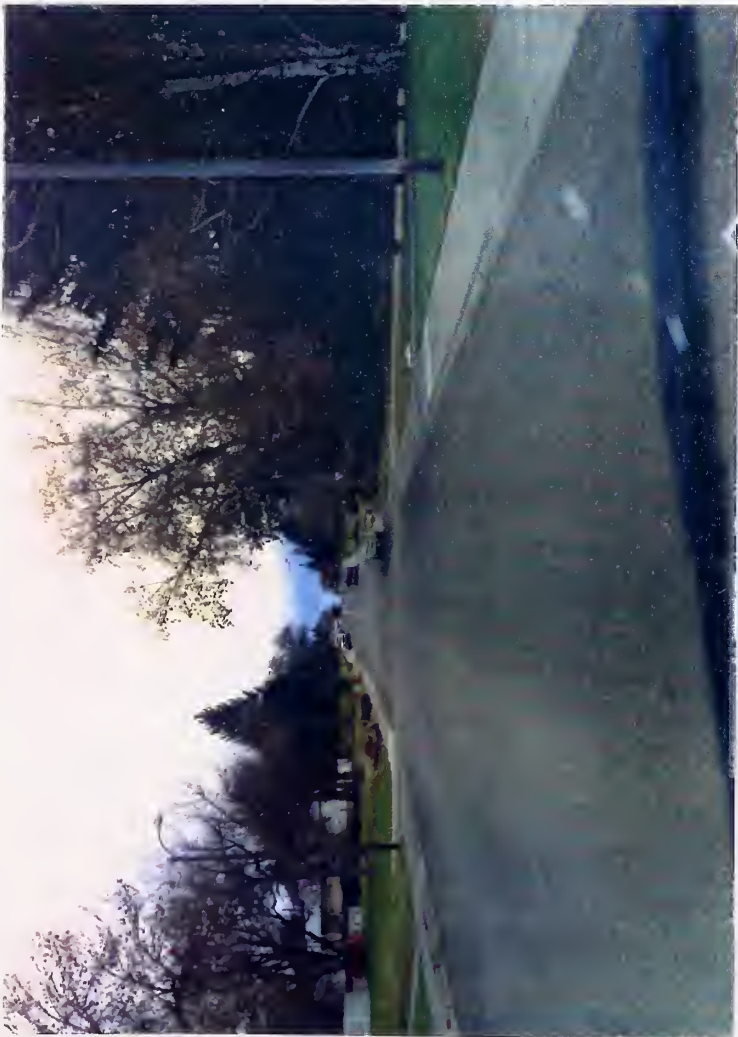
TYPES	NUMBER	ROAD	
ANGLE	6	DRY	14%
REAR END	0	WET	0%
SIDESWIPE	0	SNOW	29%
PEDEST.	0	ICE	57%
OTHER	1	OTHER	0%



FIFTH AVENUE S, LOOKING WEST



23RD STREET S, LOOKING SOUTH



FIFTH AVENUE S, LOOKING EAST



23RD STREET S, LOOKING NORTH

TRAFFIC OPERATIONS

The intersection of 5th Avenue S. and 23th Street S. is typical of most local intersections in the newer subdivisions within Great Falls. There are no traffic control devices relative to the intersection and there are no street name signs. Traffic on 5th Ave. S. is slightly higher than on 23rd St. South. There are sight distance restrictions in the southeast quadrant caused by evergreen trees. Parked vehicles may also cause temporary sight problems. There is a substantial downgrade on 23rd Street from north to south. During the data collection phase of this project, it was observed that vehicles approaching on 5th Ave. slowed and yielded to vehicles on 23rd Street.

IMPROVEMENTS

Accident statistics at this intersection indicate that 6 of the 7 accidents were angle type. All but one of the accidents occurred on icy or snowy streets which indicates a marginally hazardous situation had become more critical when stopping distance was increased by slick streets. Recommendations include trimming trees which restrict sight distance. Since this problem only accounts for three of the six accidents, it is also recommended to mark corner parking restrictions with yellow curb paint and install yield signs on 5th Avenue even though 5th has the higher traffic volumes. This degree of control is considered appropriate because grades and current driver behavior would preclude the use of yield signs on the 23rd approaches. There is no fixed pattern of stop and yield signs in the area of this intersection which establish through streets and thus, this recommendation would not have far reaching effects on the surrounding street system.

FIFTH AVENUE S. & 23RD STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	700
SOUTH APP	600
EAST APP	1200
WEST APP	1200

EXISTING CONTROL:

NONE	YES
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	YES
STOP	
SIGNAL	
MARKING	
GUIDANCE	
WARNING	

ESTIMATED COST:

TOTAL	\$330
MDOT FUND	\$200
CITY FUND	\$130

% ACCIDENT REDUCTION:

INJ/FTL	0%
PDO	43%

BENEFIT/COST RATIO:

12.02

	INDEX VALUE	SITE RANK
# ACCIDENTS	58	14
ACCIDENT RATE	62	3
SEVERITY	34	24
VOL/CAPACITY	12	23
SIGHT DIST.	32	20
DRIVER EXPECT	75	6
INFO DEFICIENT	83	1
HAZARD INDEX	53.8	16
B/C RATIO	54	15

PRIORITY	53.87	14
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**SITE
NUMBER**

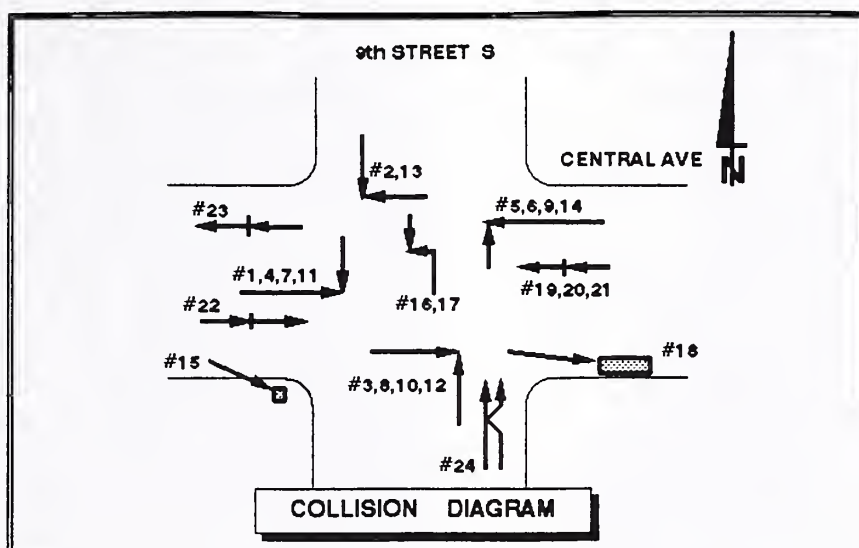
15

CENTRAL AVENUE

and

9TH STREET

ACCIDENT SUMMARY CENTRAL AVE & 9TH STREET S



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	7	14	88	636	PROP DAM	CLEAR	DRY	DAY
2	ANGLE	8	1	88	301	PROP DAM	CLEAR	DRY	NITE
3	ANGLE	8	2	88	658	PROP DAM	CLEAR	DRY	DAY
4	ANGLE	7	15	89	2135	PROP DAM	CLEAR	ICY	DAY
5	ANGLE	7	15	89	2237	PROP DAM	RAIN	WET	NITE
6	ANGLE	9	19	89	644	INJURY	CLEAR	DRY	NITE
7	ANGLE	3	17	90	47	PROP DAM	CLEAR	DRY	NITE
8	ANGLE	7	14	90	19	PROP DAM	CLEAR	DRY	NITE
9	ANGLE	8	19	90	2239	PROP DAM	CLEAR	WET	NITE
10	ANGLE	10	13	90	218	PROP DAM	CLEAR	DRY	NITE
11	ANGLE	10	14	90	1512	PROP DAM	CLEAR	DRY	DAY
12	ANGLE	11	22	90	118	PROP DAM	CLEAR	DRY	NITE
13	ANGLE	1	3	91	1840	PROP DAM	CLEAR	ICY	NITE
14	ANGLE	1	5	91	1512	PROP DAM	CLEAR	ICY	DAY
15	FIXED OBJ	8	29	89	1609	PROP DAM	CLEAR	DRY	DAY
16	LEFT TURN	12	5	90	1248	PROP DAM	CLEAR	DRY	DAY
17	LEFT TURN	12	11	90	1221	PROP DAM	CLEAR	DRY	DAY
18	PARKED CAR	12	1	88	1828	PROP DAM	CLEAR	DRY	NITE
19	REAREND	9	30	88	2155	PROP DAM	CLEAR	DRY	NITE
20	REAREND	7	22	89	2013	PROP DAM	CLEAR	DRY	DAY
21	REAREND	9	26	89	1703	PROP DAM	CLEAR	DRY	DAY
22	REAREND	12	15	89	1557	INJURY	CLEAR	SNOW	DAY
23	REAREND	1	10	90	1511	PROP DAM	CLEAR	DRY	DAY
24	SIDESWIPE	11	14	90	1033	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO.	ACC.	YEAR		
5	1988	NO. INJURY	2	
7	1989	NO. FATAL	0	
10	1990	NO. PDO	22	
2	1991	Pers Inj = 4		
24	TOTAL	NIGHTIME	50%	

TYPES	NUMBER	ROAD	
ANGLE	14	DRY	75%
REAR END	5	WET	13%
SIDESWIPE	1	SNOW	4%
LEFT TRN	2	ICE	8%
OTHER	2	OTHER	0%



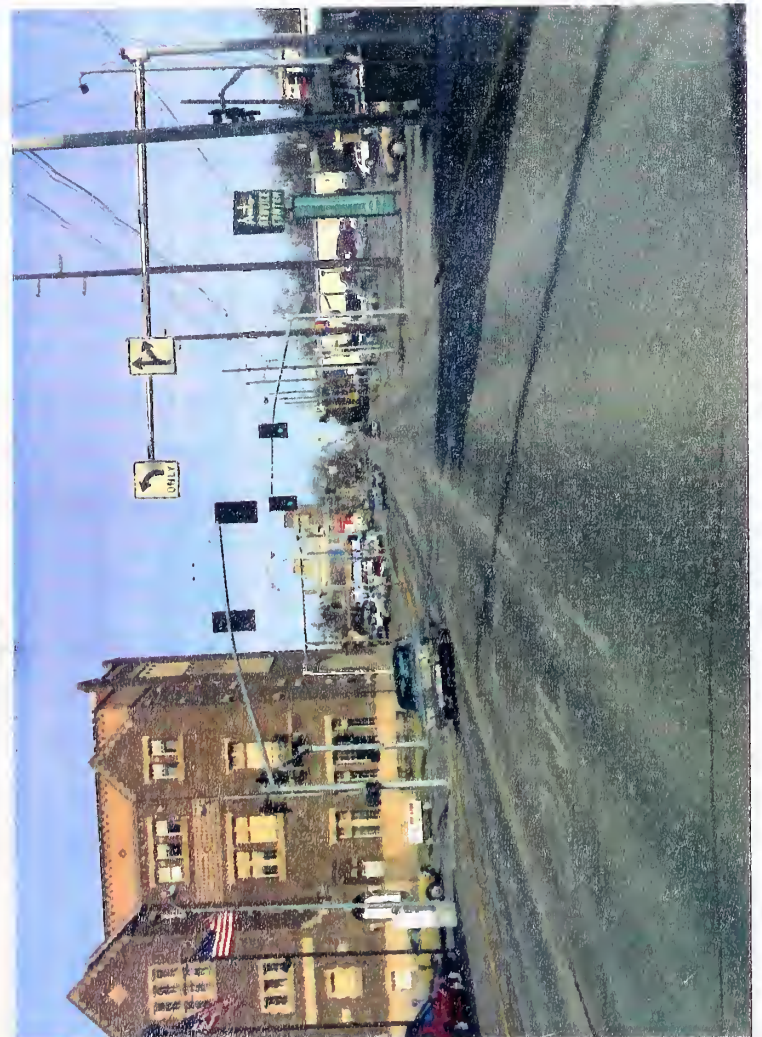
CENTRAL AVENUE, LOOKING WEST



9TH STREET, LOOKING SOUTH



CENTRAL AVENUE, LOOKING EAST



9TH STREET, LOOKING NORTH

TRAFFIC OPERATIONS

The intersection of Central Avenue and 9th Street S. is a signalized intersection. Both streets are two way streets with auxiliary left turn lanes. this intersection is on the fringe of the CBD area and is the first signal in the CBD when approaching from the east. The signal at this intersection is the only signal on Central Avenue which utilizes mast arm indications. Some of the initial observations at this intersection indicated the following:

Mast mounted signals extend well into the lanes and overlap in opposite directions so that at a distance the back of the near side signal can hide the approaching signal face.

The westbound approach has three approach lanes because Central Avenue east of 9th has a four lane street section while there are only three lanes west of 9th. The lane drop in the westbound direction is accomplished by providing a right turn lane. However, this situation causes the middle thru lane to partially line up within the left turn lane for eastbound traffic.

Lane control signs for both the northbound and southbound approaches are mounted overhead in advance of the signal and tend to overshadow the signal indications. This situation requires a driver to direct his attention to two separate locations. From a distance, the signs actually obscure the signals.

There are no street name signs at this intersection. Since this is the first major intersection in the CBD, absence of street name sign is a critical factor which is required for driver navigation tasks.

Corner signal poles are in awkward locations. In the northeast corner, the pole is located in the exact center of a new wheel chair ramp. In the southeast corner, the pole is located approximately 15 feet east of the corner which puts the ped walk indications way out of practical alignment. In both the north

and southwest corners the signal poles are located next to the curb and at least one of the study accidents involves a collision with these poles.

Traffic volumes are not extremely high at this intersection and existing signal timing provides a good level-of-service.

IMPROVEMENTS

There were 14 angle accidents, 5 rearend, 2 left turn and other single type accidents at this location. Of the 14 angle accidents, 4 were attributed to running the red in the northbound direction while 7 occurred while the signal was in flashing operation at night. The flashing operation includes a yellow on Central and a red on 9th Street. Since traffic volumes are significantly higher on 9th, the only reason Central could have been assigned the caution is because of system continuity. Because of accident experience, it is evidently not sufficient reason and it is recommended that either the lights be modified to flash all red or remain on a normal daytime cycle.

Use of a 12"x8"x8" signal indication has been widely accepted within the past ten to twenty years. Rarely is a 12"x12"x12" indication used. There is much controversy over the need for a straight 12" signal head and thus far no statistics are available to support claims either way. A logical examination of their use may shed more light on the subject. A 12" red lense only serves those drivers who have already seen the yellow; those who are already stopped; and those who are approaching and are anticipating the change to red. Twelve inch green lenses improve visibility for those who are approaching the signal by alerting them to the presence of a signal; providing information which can be used to calculate desired speed; and alerting them to the potential for change. The twelve inch yellow improves visibility for approaching drivers and serves to alert them that the red stop condition is imminent and allows them to decide the proper course of action. When these facts are considered, use of a 12" red lense for improved visibility is not nearly as important as use of 12" yellow and green lenses. As far as driver

perception and reaction is concerned, need for the red lense is always after the fact. In other words, when the red lense is illuminated, it is too late for any safe action other than to remained stopped. It is therefore recommended that mast arm signal indications should be changed to a 12"x12"x12" type.

In addition, the advance mast arm lane control signs should be removed and new left turn only signs should be mounted on the signal masts where the end of arm indications currently exist. Since there is no separate phase for the left turn lanes signals must not be mounted within those lanes. To further improve visibility the new mast signal heads must be relocated on the arms to align with individual or shared lanes.

Street name signs with 8" upper case letters should be mounted on the mast arms, close to the pole end. Signs smaller than these and signs which are located anywhere other than on the mast, become lost at these type intersections.

The westbound approach lanes must be remarked 6' to the north to align the thru lane with the following departure lane to the west. This will push the exclusive right turn lane toward the curb where there are current parking restrictions. A new R3-7r right lane sign must be installed at the beginning of the lane transitions to provided adequate regulation in the exclusive use of that lane. The exclusive nature of that lane should be emphasized by marking turkey tracks along the outside radius of the turn.

CENTRAL AVENUE & 9TH STREET

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	8000
SOUTH APP	8200
EAST APP	6200
WEST APP	6500

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	YES

RECOMMENDED CONTROL:

PARKING	
YEILD	
STOP	
SIGNAL	YES
MARKING	YES
GUIDANCE	YES
REGULATORY	YES

ESTIMATED COST:

TOTAL	\$6,400
MDOT FUND	\$1,120
CITY FUND	\$5,280

% ACCIDENT REDUCTION:

INJ/FTL	40%
PDO	48%

BENEFIT/COST RATIO:

13.72

	INDEX VALUE	SITE RANK
# ACCIDENTS	90	1
ACCIDENT RATE	32	15
SEVERITY	43	17
VOL/CAPACITY	50	11
SIGHT DIST.	28	23
DRIVER EXPECT	58	20
INFO DEFICIENT	63	15
HAZARD INDEX	52	21
B/C RATIO	57	14

PRIORITY	53.65	15
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**SITE
NUMBER**

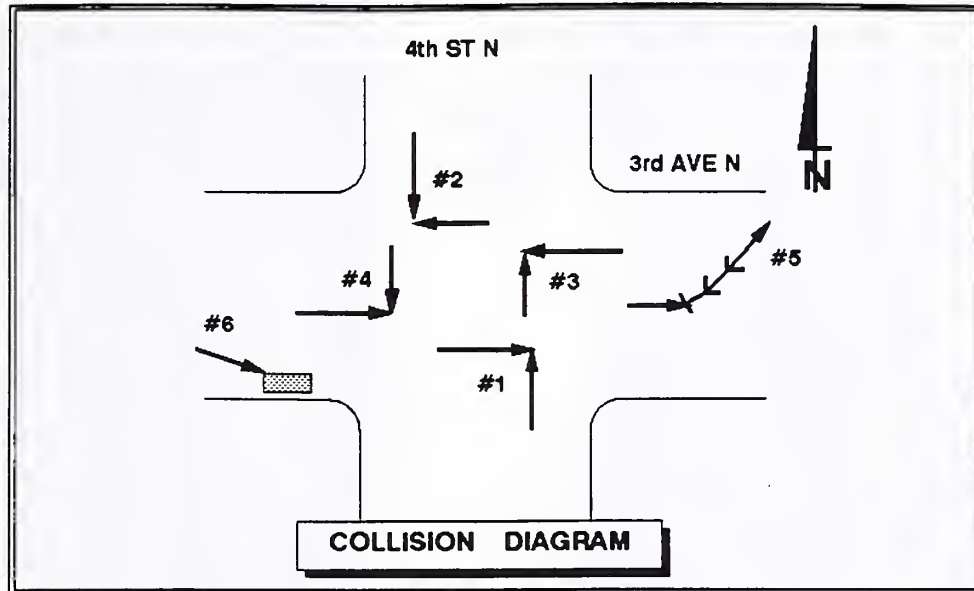
16

THIRD AVENUE N.

and

4TH STREET N.

ACCIDENT SUMMARY **THIRD AVE N & 4TH STREET N**



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	5	23	88	1043	PROP DAM	CLEAR	DRY	DAY
2	ANGLE	8	5	88	726	INJURY	CLEAR	DRY	DAY
3	ANGLE	1	6	90	1148	PROP DAM	CLEAR	DRY	DAY
4	ANGLE	12	11	90	1557	PROP DAM	CLEAR	DRY	DAY
5	BACKING	3	9	89	1706	PROP DAM	CLEAR	SNOW	DAY
6	PARKED CAR	5	25	90	1400	PROP DAM	RAIN	WET	DAY

ACCIDENT STATISTICS

NO.	ACC.	YEAR		
2	1988	NO. INJURY	1	
1	1989	NO. FATAL	0	
3	1990	NO. PDO	5	
0	1991	Pers Inj = 1		
6	TOTAL	NIGHTTIME	0%	

TYPES	NUMBER	ROAD	
ANGLE	4	DRY	67%
REAR END	0	WET	17%
SIDESWIPE	0	SNOW	17%
LEFT TRN	0	ICE	0%
OTHER	2	OTHER	0%



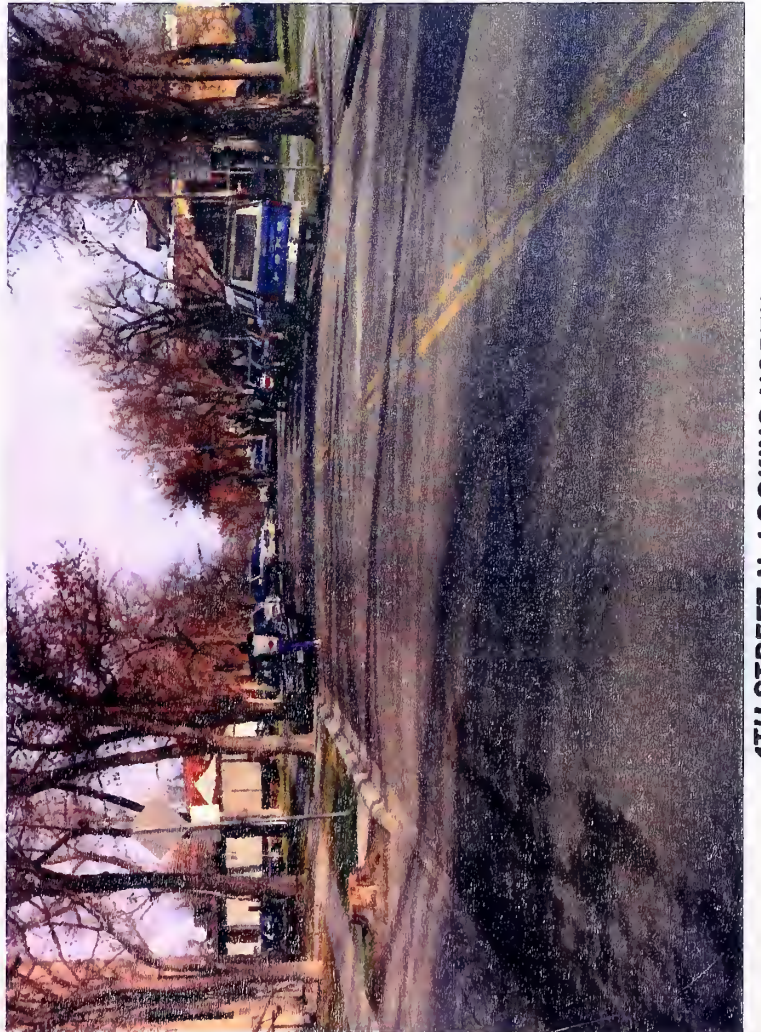
3RD AVENUE N, LOOKING WEST



4TH STREET N, LOOKING SOUTH



3RD AVENUE N, LOOKING EAST



4TH STREET N, LOOKING NORTH

TRAFFIC OPERATIONS

The intersection of 3rd Avenue N. and 4th Street N. is located on the northern fringe of the CBD. The intersection is surrounded by office and local government buildings. There are heavy turning movements at this intersection because a large portion of the traffic is circulation type traffic. Observations at this intersection indicated that there is significant parking activity on all sides of the street. Pedestrian activity is confined to the sidewalks with very rare street crossings at the intersection. Because 3rd Avenue traffic tends to have a higher percentage of longer trip lengths at this location, vehicle speeds seem to be higher. A higher number of vehicles slow for the intersection in the north-south directions.

IMPROVEMENTS

Four of the six accidents at this intersection were angle accidents. All four accidents involved different quadrants of the intersection. Sight restrictions are not obvious although illegally parked vehicles may have caused temporary sight restrictions. A more palatable explanation for accidents at this location is driver inattention due to a mixture of thru traffic and parking circulation traffic. In order to reduce the potential for driver error at this location, it is recommended that stop signs be installed on both 4th Street N. approaches. Even though traffic volumes do not favor a particular direction, an existing midblock cross walk on 4th would be better accommodated by this recommendation. The stop condition would also inconvenience the fewest number of drivers because of the high volume of northbound right turning vehicles which must slow anyway. The stop signs will remove one or more driver decisions at the intersection area and increase the drivers capacity to navigate and scan for conflicts.

In addition to the signs, centerlines and stop bars should be installed on 4th to emphasize the stop and provide guidance. Curbs should also be painted yellow in restricted zones to provide added emphasis to parking restrictions.

THIRD AVENUE N. & 4TH STREET N.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1200
SOUTH APP	2200
EAST APP	2100
WEST APP	1300

EXISTING CONTROL:

NONE	YES
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
GUIDANCE	YES
REGULATORY	

ESTIMATED COST:

TOTAL	\$1,320
MDoT FUND	\$600
CITY FUND	\$720

% ACCIDENT REDUCTION:

INJ/FTL	70%
PDO	42%

BENEFIT/COST RATIO:

19.41

	INDEX VALUE	SITE RANK
# ACCIDENTS	54	23
ACCIDENT RATE	34	13
SEVERITY	43	19
VOL/CAPACITY	29	16
SIGHT DIST.	71	13
DRIVER EXPECT	58	18
INFO DEFICIENT	67	13
HAZARD INDEX	48.5	24
B/C RATIO	64	12

PRIORITY	53.62	16
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**SITE
NUMBER**

17

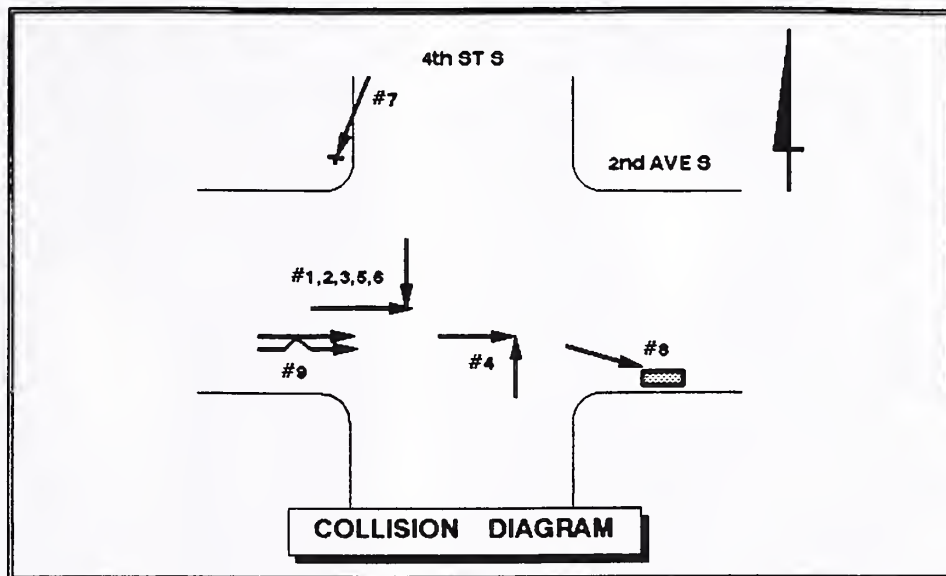
SECOND AVENUE S.

and

4TH STREET S.

ACCIDENT SUMMARY

SECOND AVE S & 4TH STREET S

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
1	1988	NO. INJURY	1
3	1989	NO. FATAL	0
3	1990	NO. PDO	8
2	1991	Pers Inj = 1	
9	TOTAL	NIGHTTIME	33%

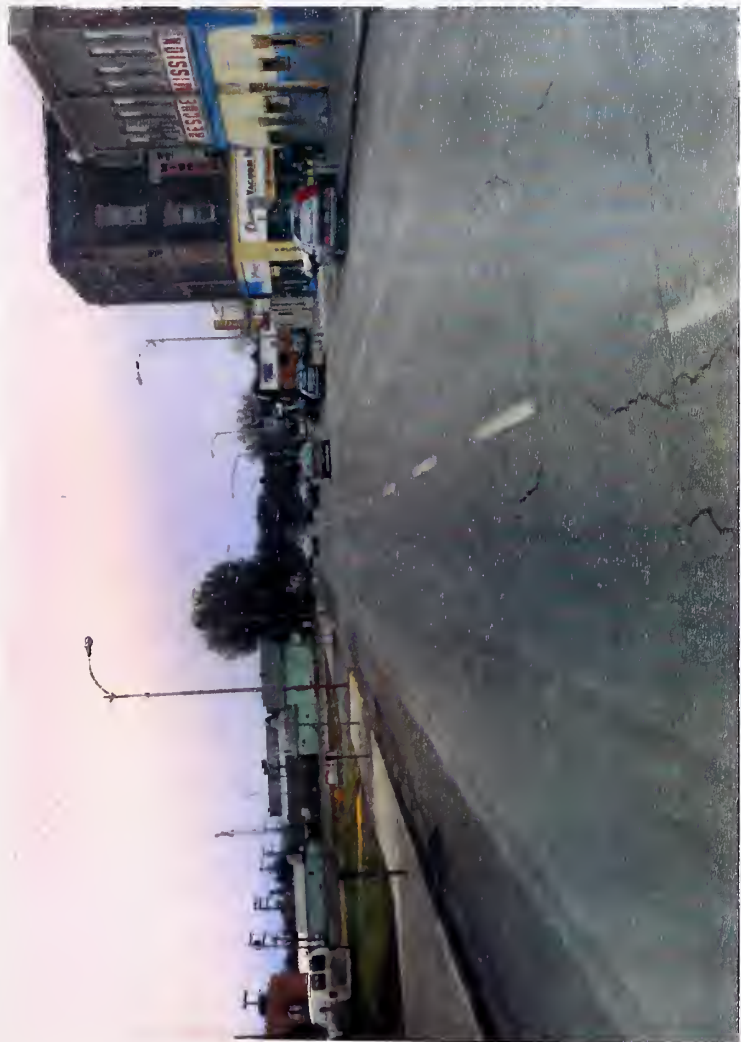
TYPES	NUMBER	ROAD	
ANGLE	6	DRY	44%
REAR END	0	WET	11%
SIDESWIPE	1	SNOW	33%
LEFT TRN	0	ICE	11%
OTHER	2	OTHER	0%



4TH ST. S, SIGNS IN NW CORNER



4TH STREET S. LOOKING SOUTH



SECOND AVENUE S, LOOKING EAST



4TH STREET S, LOOKING NORTH

TRAFFIC OPERATIONS

The intersection of 2nd Avenue S. and 4th Street S. is located within the CBD. The intersection has two large buildings located in the southern quadrants and two parking lots in the northern. Second Avenue S. is a one-way street (eastbound) with three traffic lanes and parking both sides and 4th Street is a two-way two lane street with parking. The southbound approach on 4th has an additional left turn lane. Turning movements from 4th Street are equal to thru traffic and turning movements from Second Avenue are very light. Pedestrian activity is minimal. Average speeds on Second Avenue are in excess of 30 mph and less on 4th Street. The most obvious deficiency at this intersection is the centerline offset on 4th. Markings for the left turn bay on the north side has created a jogged alignment for northbound thru traffic on 4th.

IMPROVEMENTS

Six of the nine accidents at this intersection were angle accidents. All but one of these accidents involved southbound and eastbound vehicles. According to accident reports there were various reasons for the angle accidents. One of the southbound accidents was due to loss of sight distance caused by thru and left turn vehicles stopped side by side. The left turning vehicle blindly pulled onto Second Avenue South. This is a common occurrence at two lane stop approaches. Two of the other southbound and the one northbound vehicle accidents were a result of failure to stop. The remaining angle accident and a sideswipe directly involved a snow bank in the middle of the street.

Oversize stop signs mounted at 7' to the bottom of the sign are recommended to improve visibility of the stop condition. Increased parking restrictions are also recommended to increase visibility of higher speed traffic on 2nd from the side streets. Transitioning of the south approach centerline to shift it 8' east to line up with the north centerline is desirable since it positions vehicles farther from oncoming traffic and improves total sight distance. It also improves vehicle operations by better defining lane usage. Turning restriction signing is also required to comply with MUTCD guidelines.

SECOND AVENUE S. & 4TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1500
SOUTH APP	1100
EAST APP	4300
WEST APP	4200

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
GUIDANCE	YES
REGULATORY	YES

ESTIMATED COST:

TOTAL	\$2,380
MDoT FUND	\$640
CITY FUND	\$1,740

% ACCIDENT REDUCTION:

INJ/FTL	60%
PDO	38%

BENEFIT/COST RATIO:

9.91

	INDEX VALUE	SITE RANK
# ACCIDENTS	64	12
ACCIDENT RATE	33	14
SEVERITY	40	20
VOL/CAPACITY	44	15
SIGHT DIST.	100	2
DRIVER EXPECT	50	23
INFO DEFICIENT	72	10
HAZARD INDEX	52.1	20
B/C RATIO	50	16

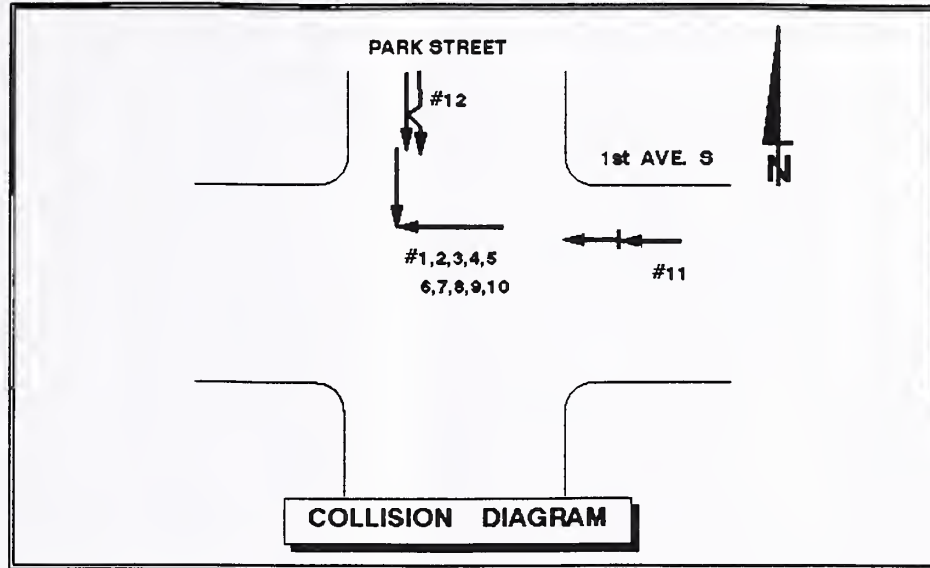
PRIORITY	51.41	17
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**SITE
NUMBER**

18

**FIRST AVENUE S.
and
PARK DRIVE**

ACCIDENT SUMMARY **1ST AVENUE S & PARK STREET**



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	2	17	88	934	INJURY	CLEAR	DRY	DAY
2	ANGLE	4	23	88	1408	PROP DAM	CLEAR	DRY	DAY
3	ANGLE	5	20	88	1225	INJURY	CLEAR	DRY	DAY
4	ANGLE	8	3	88	1419	PROP DAM	CLEAR	DRY	DAY
5	ANGLE	11	18	88	1242	PROP DAM	CLEAR	WET	DAY
6	ANGLE	3	9	89	1213	PROP DAM	CLEAR	DRY	DAY
7	ANGLE	4	7	89	1345	PROP DAM	CLEAR	DRY	DAY
8	ANGLE	5	18	89	1201	PROP DAM	RAIN	WET	DAY
9	ANGLE	6	2	89	1154	PROP DAM	CLEAR	DRY	DAY
10	ANGLE	4	6	90	1516	PROP DAM	CLEAR	DRY	DAY
11	REAREND	12	8	89	1234	PROP DAM	CLEAR	SNOW	DAY
12	SIDESWIPE	3	12	89	108	PROP DAM	CLEAR	DRY	NITE

ACCIDENT STATISTICS

NO.	ACC.	YEAR		
5	1988	NO. INJURY	2	
6	1989	NO. FATAL	0	
1	1990	NO. PDO	10	
0	1991	Pers Inj =	2	
12	TOTAL	NIGHTIME	8%	

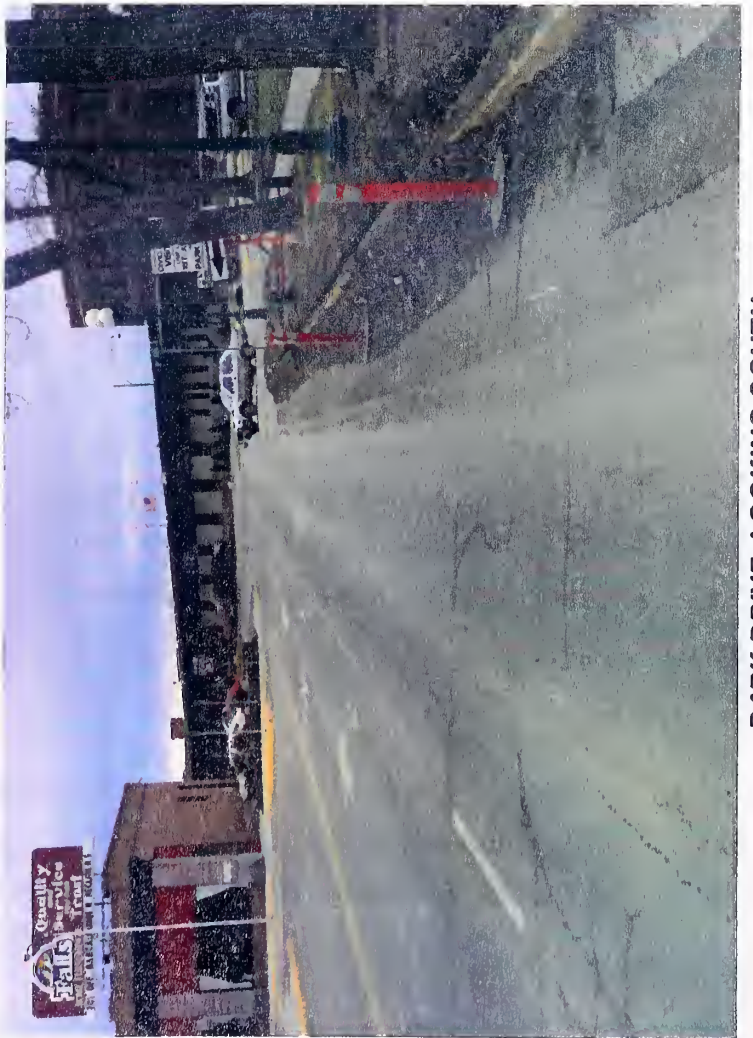
TYPES	NUMBER	ROAD	
ANGLE	10	DRY	75%
REAR END	1	WET	17%
SIDESWIPE	1	SNOW	8%
PEDEST.	0	ICE	0%
OTHER	0	OTHER	0%



FIRST AVENUE S, LOOKING EAST



FIRST AVENUE S, LOOKING WEST



PARK DRIVE, LOOKING SOUTH



FIRST AVENUE S, LOOKING NORTH

TRAFFIC OPERATIONS

Park Drive and First Avenue S. is located within the CBD. The intersection appears to have undergone some reconstruction within the past few years. Geometry and lane configuration is difficult to explain and reference to the existing condition and short term improvement drawings is required to understand traffic operations and improvement discussions.

The obvious deficiency associated with this intersection involves the westbound, one-way approach. This approach has three lanes. The left and right lanes are turn lanes and the center lane is a thru lane into the Civic Center complex. An extremely small island is located in the throat of this approach which is obviously intended to protect a stop sign. Because of an extreme curblane offset, the crosswalk and stop bar is located a full 25' east of its ideal position and fully east of the small island. Vehicles stopped at the stop bar location cannot see traffic approaching from the north because the right turn lane, which is the heavy traffic movement, is a yield and vehicles are continually within the radius portion of the turn. Almost all other movements within the intersection area block the sight distance of thru and left turn traffic from their vantage point, 30 feet east of the curb radius point. It was observed that a high percentage of thru and left turn approach vehicles do not even bother to stop, probably because of the unlikely position from which they are required to do so.

In addition, all of the crosswalks are marked at least 12' in width. The wide crosswalks steal 4' from the advance of the stop bar and encourage pedestrians to wander at a diagonal.

The right turn yield would be completely unnecessary if the intersection were marked correctly. Theoretically, there are no conflicting movements for the right turn movement. If properly protected, it should be a free flow movement.

IMPROVEMENTS

Ten angle accidents, all involving southbound and westbound vehicles, accurately reflect the observed operating deficiencies at this intersection. A rear end accident in the westbound right turn lane also indicates the extent of problems associated with the right turn yield operation.

The short term improvement sketch illustrates the proposed improvements as hereafter described.

Most traffic and transportation references indicate that traffic islands less than 200 square feet in area should never be constructed. The island concept, in this case, was a good idea but it needs to be much larger. Therefore a new traffic island is recommended which will properly delineate the free flow right turn; provide a pedestrian refuge so that the crosswalk can be moved to its proper location; and thus, the stop bar can be situated at a point where required sight distance can be attained. Construction of the new island will require removal of the north side crosswalk which cannot be properly protected from turning vehicles. If any volume of tractor-trailer traffic use the right turn lane from First Avenue S., design of the curb radius and island curb should accommodate that design vehicle.

Other recommended improvements include advance lane assignment regulatory signing; pedestrian control signing; additional one-way and turn prohibition signing; and revisions to pavement markings.

Because of the high right turn traffic volumes at this intersection, most of First Ave. traffic operates on a free flow basis. Traffic volumes on Park Drive are relatively low and thus, traffic signal warrant analysis was not completed at this intersection. Significant volume increases on Park Drive would be necessary to meet minimum volume warrants.

Due the complexity of recommended improvements at this intersection, it is recommended that detailed design plans and specifications be prepared prior to attempting implementation.

FIRST AVENUE S. & PARK DRIVE

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	7900
SOUTH APP	4200
EAST APP	4300
WEST APP	2700

EXISTING CONTROL:

NONE	
YIELD	YES
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
CONSTRUCTION	YES
REGULATORY	YES

ESTIMATED COST:

TOTAL	\$10,940
MDoT FUND	\$1,780
CITY FUND	\$9,160

% ACCIDENT REDUCTION:

INJ/FTL	60%
PDO	54%

BENEFIT/COST RATIO:

5.92

	INDEX VALUE	SITE RANK
# ACCIDENTS	72	8
ACCIDENT RATE	24	22
SEVERITY	39	22
VOL/CAPACITY	51	10
SIGHT DIST.	97	10
DRIVER EXPECT	72	7
INFO DEFICIENT	78	4
HAZARD INDEX	55.5	10
B/C RATIO	39	19

PRIORITY	50.06	18
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**SITE
NUMBER**

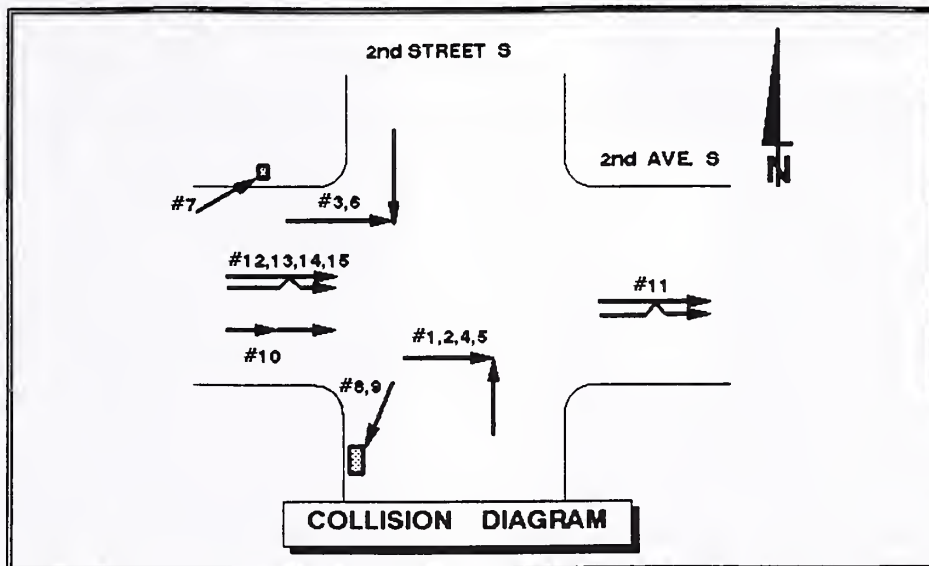
19

SECOND AVENUE S.

and

2ND STREET S.

ACCIDENT SUMMARY 2ND AVENUE S & 2ND STREET S



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	3	16	89	1002	PROP DAM	SNOW	ICY	DAY
2	ANGLE	1	18	90	1223	PROP DAM	CLEAR	DRY	DAY
3	ANGLE	2	16	90	836	INJURY	CLEAR	DRY	DAY
4	ANGLE	3	23	90	2342	PROP DAM	CLEAR	DRY	NITE
5	ANGLE	4	4	90	140	INJURY	RAIN	WET	NITE
6	ANGLE	1	26	91	2357	PROP DAM	CLEAR	DRY	NITE
7	FIXED OBJ	1	8	90	154	INJURY	CLEAR	DRY	DAY
8	PARKED CAR	6	20	89	2223	PROP DAM	CLEAR	DRY	NITE
9	PARKED CAR	12	4	89	1403	PROP DAM	CLEAR	DRY	DAY
10	REAR END	11	26	88	1411	INJURY	CLEAR	ICY	DAY
11	SIDESWIPE	5	26	89	1204	PROP DAM	CLEAR	DRY	DAY
12	SIDESWIPE	6	12	90	1404	PROP DAM	CLEAR	DRY	DAY
13	SIDESWIPE	6	17	90	1524	PROP DAM	CLEAR	DRY	DAY
14	SIDESWIPE	8	30	90	1303	PROP DAM	CLEAR	DRY	DAY
15	SIDESWIPE	12	31	90	1154	PROP DAM	CLEAR	ICY	DAY

ACCIDENT STATISTICS

NO.	
ACC.	YEAR
1	1988
4	1989
9	1990
1	1991
15	TOTAL

NO. INJURY	4
NO. FATAL	0
NO. PDO	11
Pers Inj = 4	
NIGHTTIME	27%

TYPES	NUMBER	ROAD	
ANGLE	6	DRY	29%
REAR END	1	WET	14%
SIDESWIPE	5	SNOW	14%
PEDEST.	0	ICE	43%
OTHER	3	OTHER	0%



SECOND AVENUE S, LOOKING WEST



SECOND AVENUE S, LOOKING EAST



2ND STREET S, LOOKING NORTH



2ND STREET S, LOOKING SOUTH

TRAFFIC OPERATIONS

The intersection of Second Avenue S. and 2nd Street S. is a signalized intersection. Second Avenue is a one-way street (eastbound) and 2nd Street is a two way street with an auxiliary left turn lane southbound. This intersection is within the CBD area. Some of the initial observations at this intersection indicated the following:

Mast mounted signals for southbound traffic extend well beyond their respective lanes. The indication intended for thru traffic is actually over the left turn lane and the left turn signal overlaps into the lane in the opposite direction and obscures the single signal head for northbound traffic (at a distance).

Thru arrow lenses are used on two of the signal heads. While use of these arrows, according to MUTCD, in this situation is not prohibited, there is really no good reason for this application. The arrows do not apply to an unusual or unique movement while their use only serves to reduce overall visibility.

The eastbound approach present very unusual lane control problems. West of the intersection, a narrow two lane, one-way street has a sharp curvilinear alignment immediately followed by a three lane approach with parking on both sides. This provides a 30' to 56' transition within a distance of 25 feet. There are no signs to indicate the lane usage.

The lane transitions, unexpected signal, approach geometry, and parking and loading activities near the intersection presents a driver information overload of epic proportions.

There are very minimal one-way and turn prohibition signing at this intersection. Their presence would at least provide a clue to proper travel paths thru this intersection.

There are no street name signs at this intersection. Since street geometry is so unique in this area, street name signs are critical for driver navigation tasks.

Traffic volumes are not extremely high at this intersection and existing signal timing provides a good level-of-service.

IMPROVEMENTS

There were 6 angle accidents, 5 sideswipe, 1 rearend and 4 accidents involving single vehicles at this location. The angle accidents must be attributed to positioning, size and type of the signal indications rather than timing. Lack of warning of the signal's presence for eastbound traffic undoubtedly played some role in angle accident experience. In order to improve this situation, it is recommended that 12"x8"x8" signal heads be replaced with 12"x12"x12" heads at new locations on the mast arms.

Use of a 12"x8"x8" signal indication has been widely accepted within the past ten to twenty years. Rarely is a 12"x12"x12" indication used. There is much controversy over the need for a straight 12" signal head and thus far no statistics are available to support claims either way. A logical examination of their use may shed more light on the subject. A 12" red lense only serves those drivers who have already seen the yellow; those who are already stopped; and those who are approaching and are anticipating the change to red. Twelve inch green lenses improve visibility for those who are approaching the signal by alerting them to the presence of a signal; providing information which can be used to calculate desired speed; and alerting them to the potential for change. The twelve inch yellow improves visibility for approaching drivers and serves to alert them that the red stop condition is imminent and allows them to decide the proper course of action. When these facts are considered, use of a 12" red lense for improved visibility is not nearly as important as use of 12" yellow and green lenses. As far as driver perception and reaction is concerned, need for the red lense is always after the fact. In other words, when the red lense is illuminated, it is too late for any safe action other than to remain stopped. It is therefore recommended that mast arm signal indications should be changed to a 12"x12"x12" type.

In addition, mast arm lane control signs should be added to the mast arms as well as street name signs with 8" upper case letters.

Sideswipe accidents usually only occur where there is confusion as to where drivers are going or what lane they should be in for their intended direction of travel. In this case, confusion is unavoidable. A two to three lane transition for thru traffic lanes would normally require at least 180' to accomplish at this design speed. Additional width added for parking makes the 25' transition extremely inadequate. The most effective solution to the eastbound approach would be reconstruction to properly introduce a third lane on the south side which could serve as a right turn lane only. However, that solution would be very expensive. The recommended short term solution would be to eliminate the third lane by separating the parking area with pavement markings. The two lane approach will then provide lane continuity to the intersection. It would also appear necessary to continue two lanes on the east side of the intersection, but markings necessary to accomplish this, would cause more confusion for traffic turning from 2nd Street than its worth. Advance lane control signing and extensive markings are required to implement this improvement.

Signing on the east bound approach should also included signal ahead warning signs. Other improvements at this intersection should include one-way and turn prohibitions according to the latest MUTCD guidelines. This project should also have more specific design plan details developed prior to implementation because of the complexity of the site and other unknown factors that may be present.

SECOND AVENUE S. & 2ND STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	6700
SOUTH APP	7100
EAST APP	3300
WEST APP	3300

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	YES

RECOMMENDED CONTROL:

PARKING	
YEILD	
WARNING	YES
SIGNAL	YES
MARKING	YES
GUIDANCE	YES
REGULATORY	YES

ESTIMATED COST:

TOTAL	\$8,650
MDoT FUND	\$1,500
CITY FUND	\$7,150

% ACCIDENT REDUCTION:

INJ/FTL	30%
PDO	50%

BENEFIT/COST RATIO:

7.42

	INDEX VALUE	SITE RANK
# ACCIDENTS	78	5
ACCIDENT RATE	29	17
SEVERITY	47	14
VOL/CAPACITY	54	9
SIGHT DIST.	21	25
DRIVER EXPECT	56	21
INFO DEFICIENT	83	2
HAZARD INDEX	52	22
B/C RATIO	44	17

PRIORITY	49.36	19
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**SITE
NUMBER**

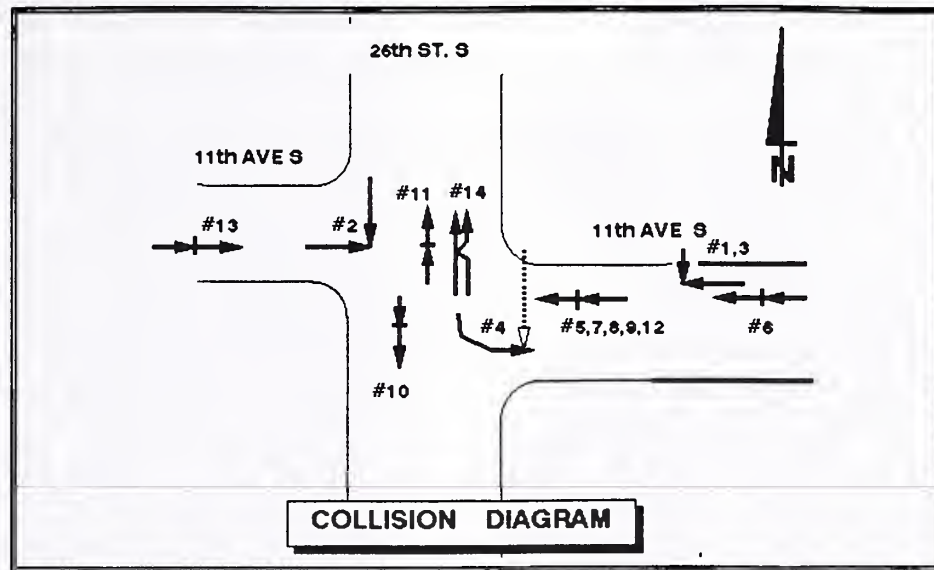
20

ELEVENTH AVENUE S.

and

26TH STREET S.

ACCIDENT SUMMARY **11TH AVENUE S & 26TH STREET S**



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	2	5	88	856	PROP DAM	CLEAR	SNOW	DAY
2	ANGLE	2	5	88	1604	PROP DAM	CLEAR	ICY	DAY
3	ANGLE	11	7	89	1617	PROP DAM	CLEAR	DRY	DAY
4	PEDESTRIAN	7	14	89	1631	INJURY	CLEAR	DRY	DAY
5	REAREND	2	9	88	1153	INJURY	CLEAR	ICY	DAY
6	REAREND	4	20	88	1609	PROP DAM	RAIN	WET	DAY
7	REAREND	1	16	89	1704	PROP DAM	CLEAR	DRY	NITE
8	REAREND	3	2	89	1703	PROP DAM	SNOW	ICY	DAY
9	REAREND	3	3	89	752	PROP DAM	CLEAR	ICY	DAY
10	REAREND	6	1	89	1228	PROP DAM	CLEAR	DRY	DAY
11	REAREND	6	12	89	1546	PROP DAM	CLEAR	DRY	DAY
12	REAREND	12	6	89	1331	PROP DAM	CLEAR	DRY	DAY
13	REAREND	7	11	90	1459	PROP DAM	CLEAR	DRY	DAY
14	SIDESWIPE	6	12	89	1645	PROP DAM	CLEAR	SNOW	DAY

ACCIDENT STATISTICS

NO.	ACC.	YEAR		
4	1988	NO. INJURY	2	
8	1989	NO. FATAL	0	
2	1990	NO. PDO	12	
0	1991	Pers Inj = 4		
14	TOTAL	NIGHTTIME	7%	

TYPES	NUMBER	ROAD	
ANGLE	3	DRY	50%
REAR END	9	WET	7%
SIDESWIPE	1	SNOW	14%
PEDEST.	1	ICE	29%
OTHER	0	OTHER	0%



ELEVENTH AVENUE S, LOOKING WEST



ELEVENTH AVENUE S, LOOKING EAST



26TH STREET S. LOOKING SOUTH



26TH STREET S. LOOKING NORTH

TRAFFIC OPERATIONS

The intersection of Eleventh Avenue S. and 26th Street S. is actually two intersections because of a 150 foot offset in the alignment of 11th Avenue South. This intersection is in the middle of a medical complex and the Deaconess Hospital is located in the southeast quadrant of the intersection. Some initial observations at this intersection indicated the following:

Streets in this area, especially 11th Avenue S. east of 26th, have numerous drive approaches to parking lots, buildings and alleys. A single parking lot for Deaconess on the north side of 11th Avenue has a minimum of 5 parallel approaches which reduces street capacity while entering and exiting traffic block each driver's line of sight. In addition pedestrians must cross 11th to get to the hospital. There are marked and signed cross walks at which accident reports indicate numerous rearend accidents.

The most obvious problem at this location is the degree of traffic volumes and turning movements within the 150' intersection offset area on 26th Street. Peak hour traffic operations indicate a great deal of delay for some of the movements.

Street widths are too narrow for traffic volumes and type of operation. Judging from developments in this area, traffic **will** increase significantly in the future and delay and accidents will increase commensurately.

IMPROVEMENTS

There were a wide variety of accident types at this intersection. The most predominate was rearend accidents. Most of those occurred on the westbound approach. The suspected cause relates to traffic delays for vehicles trying to enter 26th Street. Vehicles stopped on this approach monitor approaching traffic and often the 26th Street driver's intent is misjudged which results in false starts and sudden stops. Although street widths are not entirely adequate for three lane operations, some relief from

rear-end accidents and delay could be realized if the intersection areas provided left turn lanes. Traffic speeds are low enough in the intersection area that 11 and 12 foot lanes would not be detrimental and would hopefully result in a net accident savings. New parking restriction signs should be added to prevent occasional incidents of on-street parking.

Some of the congestion witnessed in this area also results from the signal at 26th and 10th Avenue South. Long queues build south from that intersection which affects traffic movements at the study site. The City should investigate whether it is practical to extend 26th green time at 10th Avenue S. so that the 26th queue could clear on every cycle.

Traffic signal warrants were completed for the east intersection, a summary of which can be found at the end of this section. It was determined that signals are not currently warranted, but could be in the near future if development and traffic continue to increase.

The recommended short term improvements are made with some reservations. Costs in excess of \$8,000 may be better spent performing a traffic study along the 11th Avenue South corridor to determine what general improvements are needed along this corridor based on the anticipated level of area development. The 35' BC-BC street widths are only adequate for local streets carrying less than 1,000 ADT. Eleventh Ave. is currently carrying upwards of 5000 ADT and from cursory estimates, it may eventually exceed 10,000 ADT. This level of traffic will either cause innumerable traffic problems or the congestion will choke out development. Not a desirable outcome for either alternative. If a study is undertaken and future plans are set forth, they should consider transitioning 11th to the north, east of the hospital parking lot and intersecting 26th at the existing north intersection with 11th. The existing street section could then be abandoned and used by Deaconess for parking adjacent to the hospital. Re-orientation of the parking lot would be required to eliminate all of the parallel approaches.

ELEVENTH AVENUE S. & 26TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	5000
SOUTH APP	4200
EAST APP	4000
WEST APP	1700

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
GUIDANCE	
REGULATORY	YES

ESTIMATED COST:

TOTAL	\$8,120
MDOT FUND	\$600
CITY FUND	\$7,520

% ACCIDENT REDUCTION:

INJ/FTL	20%
PDO	33%

BENEFIT/COST RATIO:

3.66

	INDEX VALUE	SITE RANK
# ACCIDENTS	76	6
ACCIDENT RATE	37	12
SEVERITY	49	11
VOL/CAPACITY	72	6
SIGHT DIST.	100	9
DRIVER EXPECT	58	19
INFO DEFICIENT	54	18
HAZARD INDEX	58.1	6
B/C RATIO	29	21

PRIORITY	48.5	20
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TRAFFIC SIGNAL WARRANT ANALYSIS
YEAR 1991
ELVENTH AVE S. & 26TH ST., GREAT FALLS

WARRANT #1 - MINIMUM VEHICULAR VOLUME					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
		500	150	340	135
8TH HIGHEST HOUR					
% OF WARRANT MET				68%	90%

WARRANT #2 - INTERRUPTION OF CONTINUOUS TRAFFIC					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
		750	75	340	135
8TH HIGHEST HOUR					
% OF WARRANT MET				45%	180%

WARRANT #3 - MINIMUM PEDESTRIAN TRAFFIC					
50% WARRANT		REQUIRED		EXISTS	
YES	NO	PEDS	GAPS	PEDS	GAPS
		100	60	NA	NA
FOUR HOURS					
PEAK HOUR		190	60	NA	NA
% OF WARRANT MET				0%	ERR

WARRANT #4 - SCHOOL CROSSING [STUD	YES	NO
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WARRANT #5 - PROGRESSIVE MOVEMENT	YES	NO
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WARRANT #6 - ACCIDENT EXPERIENCE	YES	NO
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WARRANT #7 - SYSTEMS WARRANT	YES	NO
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WARRANT #8 - COMBINATION OF WARRANTS				
80 % OF WARRANTS #1 & #2	REQUIRED		EXISTS	
	MAJOR	MINOR	MAJOR	MINOR
WARRANT #1	400	120	340	135
WARRANT #2	600	60	340	135
% OF WARRANT MET			71%	169%

WARRANT #9 - FOUR HOUR VOLUMES				
	MAJOR	MINOR	CURVE NO.	WARRANT
4TH HIGHEST HOUR	430	175	FIGURE	YES
NUMBER OF LANES	1	1	4.7	NO

WARRANT #10 - PEAK HOUR DELAY				
PEAK HOUR:	MINOR LEG		TOTAL ENTERING	
	DELAY	VOLUME	4 LEGS	3 LEGS
REQUIRED VALUES	4	100	800	650
EXISTING VALUES	0.7	205	780	

WARRANT #11 - PEAK HOUR VOLUME				
	MAJOR	MINOR	CURVE NO.	WARRANT
PEAK HOUR	520	205	FIGURE	YES
NUMBER OF LANES	1	1	4.5	NO

SUMMARY OF WARRANTS SATISFIED					
WARRANT 1		WARRANT 5		WARRANT 9	
WARRANT 2		WARRANT 6		WARRANT 10	
WARRANT 3		WARRANT 7		WARRANT 11	
WARRANT 4		WARRANT 8		TOTAL =	0

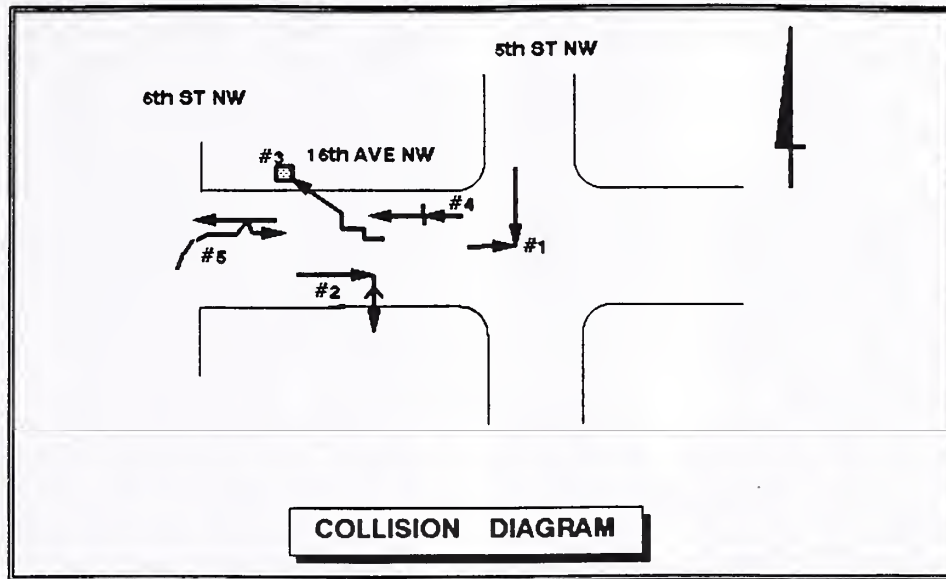
**SITE
NUMBER**

21

16TH AVENUE NW

5TH TO 6TH STREET NW

ACCIDENT SUMMARY **SIXTEENTH AVE NW, 5TH to 6TH ST NW**



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	11	9	90	1514	PROP DAM	CLEAR	DRY	DAY
2	BACKING	4	11	90	816	PROP DAM	CLEAR	DRY	DAY
3	FIXED OBJ	2	5	90	1509	INJURY	CLEAR	DRY	DAY
4	REAREND	6	5	89	1511	INJURY	CLEAR	DRY	DAY
5	SIDESWIPE	2	2	89	1623	PROP DAM	CLEAR	ICY	DAY

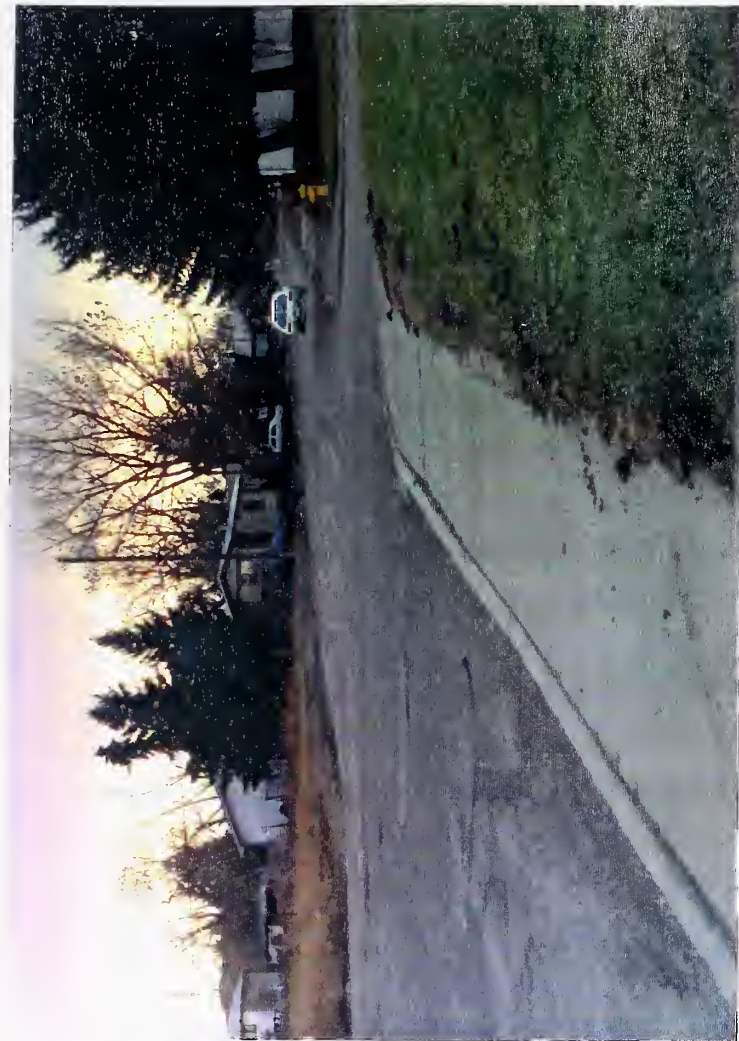
ACCIDENT STATISTICS

NO.	ACC.	YEAR		
0	1988	NO. INJURY	2	
2	1989	NO. FATAL	0	
3	1990	NO. PDO	3	
0	1991	Pers Inj = 2		
5	TOTAL	NIGHTIME	0%	

TYPES	NUMBER	ROAD	
ANGLE	1	DRY	80%
REAR END	1	WET	0%
SIDESWIPE	1	SNOW	0%
LEFT TRN	0	ICE	20%
OTHER	2	OTHER	0%



SIXTEENTH AVE NW, LOOKING EAST



SIXTEENTH AVE NW, LOOKING WEST



TRAFFIC OPERATIONS

This study site involves a section of street as well as two intersections. Sixteenth Avenue NW provides primary access to the CMR High School parking lot. Its intersection with 5th Street NW is located at the approach to the parking lot. Since the parking lot access generates very high peak volumes, it is designated as the through street. To drivers unfamiliar with the intersection, stopping street traffic for a lot drive approach does not seem natural. Drivers approaching from the west tend to slow and hesitate at this intersection because of this unexpected condition.

Sixteenth's intersection with 6th Street is a T-intersection. Sixth Street NW is a through street with higher volumes than any of the other area streets, approximately 4,000 ADT. Sixteenth Avenue's approach to 6th is a stop condition and extreme congestion occurs when school lets out in the afternoon. Traffic actually backs up to the 5th Street intersection during this period.

In addition to peak hour traffic congestion and unusual access control a number of pedestrian walk along 16th during peak vehicle periods. there are no sidewalks along 16th and no centerline striping.

IMPROVEMENTS

There were a wide variety of accident types at this location. During the reporting period there were 5 accidents total. Four of the five accidents occurred in the afternoon and one in the morning. Most of these accidents occurred during congested periods.

It is difficult to provide short term low cost improvements at this site because of the traffic complexities involved within short time periods during the day. The improvements indicated on the sketch are actually a combination of short term improvements and long term improvements. Future improvements would ideally add sidewalks and include major modifications to parking lot access.

The most drastic recommendation would be to improve capacity at the 6th Street intersection by constructing a right turn lane. This lane would allow for deceleration out of the northbound thru traffic lane and would benefit capacity

by providing side street traffic with an indication of potential conflicts from approaching traffic. Instead of waiting for gaps within all opposing traffic, side street traffic would know which approaching vehicles were committed to the right turn, thereby increasing the number of available gaps.

A centerline and white shoulder stripe would be utilized to delineate a walking/bike path along the south shoulder, which will hopefully reduce potential vehicle and pedestrian conflicts.

An oversize stop sign on the southbound 5th Street approach would replace the existing stop sign at a location nearer to the corner. School crossing marks at the 5th Street intersection will help identify thru traffic patterns as well as establish a formal crosswalk location.

Also recommended is removal of a speed bump in the parking lot approach and resurfacing the approach to increase vehicle control during entrance and exit maneuvers. The speed bump's only effect at this location is to increase vehicle speeds, since the bump becomes less noticeable the faster a vehicle travels.

SIXTEENTH AVENUE NW., 5TH TO 6TH STREET NW.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1200
SOUTH APP	700
EAST APP	1100
WEST APP	1900

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	
YIELD	
STOP	YES
SIGNAL	
MARKING	YES
CONSTRUCTION	YES
REGULATORY	YES

ESTIMATED COST:

TOTAL	\$15,360
MDOT FUND	\$1,080
CITY FUND	\$14,280

% ACCIDENT REDUCTION:

INJ/FTL	30%
PDO	40%

BENEFIT/COST RATIO:

2.48

	INDEX VALUE	SITE RANK
# ACCIDENTS	50	24
ACCIDENT RATE	48	9
SEVERITY	51	8
VOL/CAPACITY	60	7
SIGHT DIST.	100	3
DRIVER EXPECT	63	17
INFO DEFICIENT	50	19
HAZARD INDEX	56	8
B/C RATIO	20	22

PRIORITY	44.12	21
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**SITE
NUMBER**

22

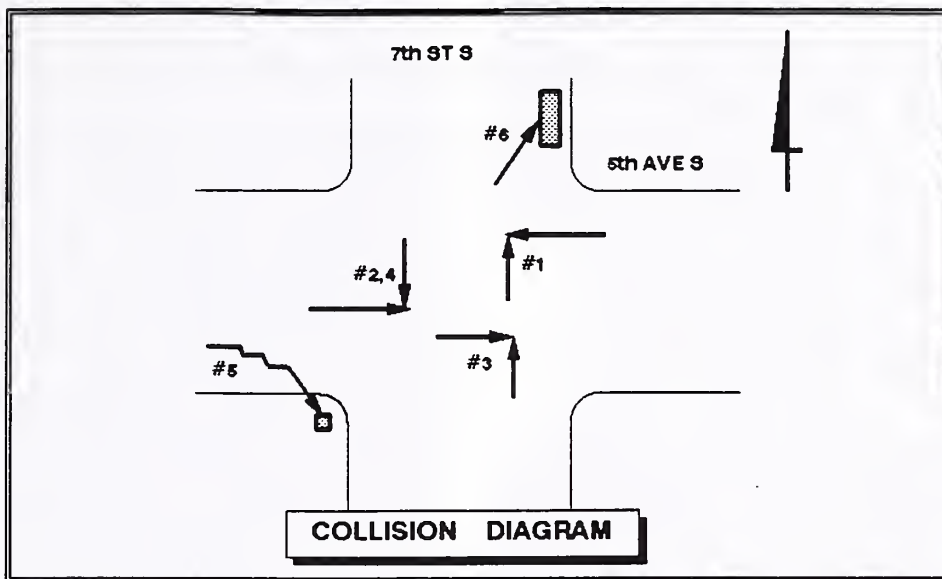
5TH AVENUE S.

and

7TH STREET S.

ACCIDENT SUMMARY

FIFTH AVE S & 7TH STREET S

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
0	1988	NO. INJURY	0
3	1989	NO. FATAL	0
3	1990	NO. PDO	6
0	1991	Pers Inj = 0	
6	TOTAL	NIGHTTIME	17%

TYPES	NUMBER	ROAD	
ANGLE	4	DRY	67%
REAR END	0	WET	17%
SIDESWIPE	0	SNOW	17%
LEFT TRN	0	ICE	0%
OTHER	2	OTHER	0%



FIFTH AVENUE S, LOOKING EAST



FIFTH AVENUE S, LOOKING WEST



7TH STREET S, LOOKING NORTH



7TH STREET S, LOOKING SOUTH

TRAFFIC OPERATIONS

The intersection of 5th Avenue S. and 7th Street S. is typical of most local intersections in the Great Falls urban area. There are no traffic control devices relative to the intersection and there are no street name signs. Traffic on 10th St. S. is slightly higher than on 8th Ave. South. There are no apparent sight restrictions other than tree trunks and parked vehicles.

Problems at this intersection are relegated to mobile and intermittent sight restrictions which may cause partial blockage or blind spots in an approaching drivers view. The exact extent of this problem is difficult to state with any certainty because of the transient nature of the problem.

IMPROVEMENTS

Accident statistics at this intersection indicate that four of the six accidents were angle type. Only one accident was on a slippery street. Since traffic volumes on 7th Street South are three times those on 5th Avenue and beyond the range of local street volumes, it is recommended that stop signs be placed on the lower volume 5th Ave. S. approaches. This action will have a dramatic effect on the angle accident problem. Curb restrictions at intersections should be reinforced by painting the curbs yellow. New street name signs will also contribute to safety of the intersection by eliminating navigation tasks from the drivers decision making duties.

FIFTH AVENUE S. & 7TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	2200
SOUTH APP	2200
EAST APP	800
WEST APP	700

EXISTING CONTROL:

NONE	YES
YIELD	
STOP	
SIGNAL	

RECOMMENDED CONTROL:

PARKING	YES
YEILD	
STOP	YES
SIGNAL	
MARKING	
GUIDANCE	YES
REGULATORY	

ESTIMATED COST:

TOTAL	\$700
MDOT FUND	\$600
CITY FUND	\$100

% ACCIDENT REDUCTION:

INJ/FTL	0%
PDO	53%

BENEFIT/COST RATIO:

5.99

	INDEX VALUE	SITE RANK
# ACCIDENTS	54	22
ACCIDENT RATE	40	10
SEVERITY	34	23
VOL/CAPACITY	25	17
SIGHT DIST.	75	12
DRIVER EXPECT	33	25
INFO DEFICIENT	42	24
HAZARD INDEX	41.5	25
B/C RATIO	39	18

PRIORITY	40.68	22
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**SITE
NUMBER**

23

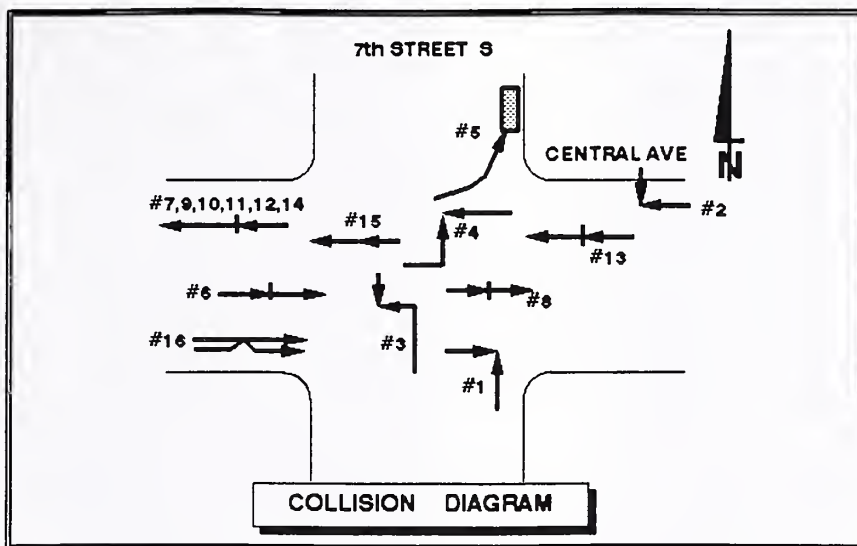
CENTRAL AVENUE

and

7TH STREET

ACCIDENT SUMMARY

CENTRAL AVE & 7TH STREET S

[illegible]

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
3	1988	NO. INJURY	2
4	1989	NO. FATAL	0
9	1990	NO. PDO	14
0	1991	Pers Inj = 4	
18	TOTAL	NIGHTTIME	56%

TYPES	NUMBER	ROAD	
ANGLE	2	DRY	81%
REAR END	10	WET	13%
SIDESWIPE	1	SNOW	8%
LEFT TRN	2	ICE	0%
OTHER	1	OTHER	0%



CENTRAL AVENUE, LOOKING WEST



7TH STREET, LOOKING SOUTH



CENTRAL AVENUE, LOOKING EAST



7TH STREET, LOOKING NORTH

TRAFFIC OPERATIONS

The intersection of Central Avenue and 7th Street is a signalized intersection which is part of the Central Avenue corridor signal system using pole top mounted, corner signals. Problems associated with this intersection are typical of other intersections on Central. The signal locations are not within the required cone of vision and are easily hidden from approaching traffic by turning and parked trucks.

IMPROVEMENTS

Accident statistics at this intersection indicate that the predominant accident type is rearend accidents, with ten of the 16 total accidents. Two of the accidents were angle and two were left turn accidents. These accident types are all typical of those which would be expected at intersections with poor signal visibility. Because no real benefits could be realized by improvements other than work on the existing signals and such work would necessarily involve installation of new poles and mast arms according to MUTCD standards, it is recommended that a new signal installation be designed and installed at this intersection. This should be completed in conjunction without corridor improvements as outlined in the main body of this report.

Final implementation of these improvements is entirely dependent upon additional study of this intersection. Traffic signal warrants were completed for this intersection. A summary of the warrant analysis is located at the end of this section. Based on this study's traffic counts, the existing signal is not currently warranted. Further traffic counts by automatic counters, 24 hours per day for at least a week, should be taken during two different seasonal time periods. Extended pedestrian counts should also be taken. If after more intensive analysis signal warrants are still not met, the City of Great Falls should consider removal of the signal installation and necessary conversion to stop control. A recent signal removal at 8th Street and Central should be assessed for accident records to determine the effect that this action may potentially have at 7th Street.

CENTRAL AVENUE & 7TH STREET

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	2400
SOUTH APP	2500
EAST APP	5700
WEST APP	5900

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	YES

RECOMMENDED CONTROL:

PARKING	
YIELD	
STOP	
SIGNAL	YES
MARKING	
GUIDANCE	
REGULATORY	YES

ESTIMATED COST:

TOTAL	\$58,520
MDoT FUND	\$1,120
CITY FUND	\$57,400

% ACCIDENT REDUCTION:

INJ/FTL	30%
PDO	27%

BENEFIT/COST RATIO:

1.04

	INDEX VALUE	SITE RANK
# ACCIDENTS	79	3
ACCIDENT RATE	37	11
SEVERITY	47	13
VOL/CAPACITY	45	14
SIGHT DIST.	29	21
DRIVER EXPECT	67	10
INFO DEFICIENT	75	6
HAZARD INDEX	54.5	13
B/C RATIO	1	24

PRIORITY	36.85	23
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**TRAFFIC SIGNAL WARRANT ANALYSIS
YEAR 1991
CENTRAL AVE & 7TH ST., GREAT FALLS**

WARRANT #1 - MINIMUM VEHICULAR VOLUME					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR		600	200	405	85
% OF WARRANT MET				68%	43%

WARRANT #2 - INTERRUPTION OF CONTINUOUS TRAFFIC					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
8TH HIGHEST HOUR		900	100	405	85
% OF WARRANT MET				45%	85%

WARRANT #3 - MINIMUM PEDESTRIAN TRAFFIC					
50% WARRANT		REQUIRED		EXISTS	
YES	NO	PEDS	GAPS	PEDS	GAPS
FOUR HOURS		100	60	40	40
PEAK HOUR		190	60	50	30
% OF WARRANT MET				26%	200%

WARRANT #4 - SCHOOL CROSSING [STUD	YES	NO
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WARRANT #5 - PROGRESSIVE MOVEMENT	YES	NO
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WARRANT #6 - ACCIDENT EXPERIENCE	YES	NO
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WARRANT #7 - SYSTEMS WARRANT	YES	NO
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WARRANT #8 - COMBINATION OF WARRANTS				
80 % OF WARRANTS #1 & #2	REQUIRED		EXISTS	
	MAJOR	MINOR	MAJOR	MINOR
WARRANT #1	480	160	405	85
WARRANT #2	720	80	405	85
% OF WARRANT MET			70%	80%

WARRANT #9 - FOUR HOUR VOLUMES				
	MAJOR	MINOR	CURVE NO.	WARRAN
4TH HIGHEST HOUR	510	110	FIGURE	YES
NUMBER OF LANES	2	2	4.7	NO

WARRANT #10 - PEAK HOUR DELAY				
PEAK HOUR:	MINOR LEG		TOTAL ENTERING	
	DELAY	VOLUME	4 LEGS	3 LEGS
REQUIRED VALUES	4	100	800	650
EXISTING VALUES	0.2	240	810	

WARRANT #11 - PEAK HOUR VOLUME				
	MAJOR	MINOR	CURVE NO.	WARRAN
PEAK HOUR	580	125	FIGURE	YES
NUMBER OF LANES	1	1	4.5	NO

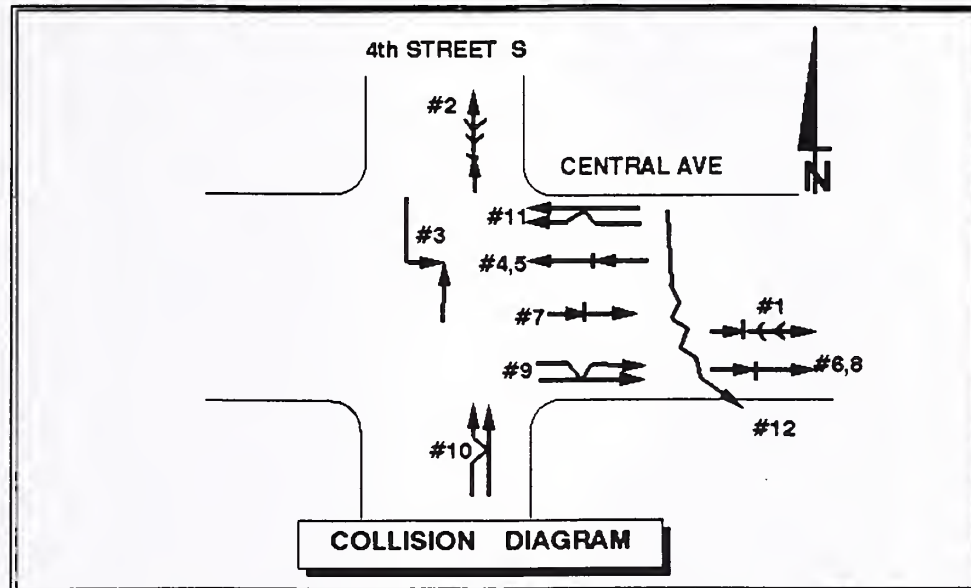
SUMMARY OF WARRANTS SATISFIED					
WARRANT 1		WARRANT 5		WARRANT 9	
WARRANT 2		WARRANT 6		WARRANT 10	
WARRANT 3		WARRANT 7		WARRANT 11	
WARRANT 4		WARRANT 8		TOTAL =	0

**SITE
NUMBER**

24

**CENTRAL AVENUE
and
4TH STREET**

ACCIDENT SUMMARY CENTRAL AVE & 4TH STREET S



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	BACKING	10	26	90	1340	PROP DAM	CLEAR	DRY	DAY
2	BACKING	11	27	90	1222	PROP DAM	CLEAR	WET	DAY
3	LEFT TURN	3	12	88	2017	PROP DAM	CLEAR	DRY	NITE
4	REAREND	4	9	88	2224	INJURY	CLEAR	DRY	NITE
5	REAREND	10	7	88	2043	PROP DAM	CLEAR	DRY	NITE
6	REAREND	10	14	88	2207	PROP DAM	CLEAR	DRY	NITE
7	REAREND	3	24	90	2200	INJURY	CLEAR	DRY	NITE
8	REAREND	7	14	90	1332	PROP DAM	CLEAR	DRY	DAY
9	SIDESWIPE	9	30	89	1254	PROP DAM	CLEAR	DRY	DAY
10	SIDESWIPE	1	12	90	1149	PROP DAM	CLEAR	DRY	DAY
11	SIDESWIPE	9	15	90	2321	PROP DAM	CLEAR	DRY	NITE
12	SINGLE VEH	8	31	88	1623	PROP DAM	CLEAR	DRY	DAY

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
5	1988	NO. INJURY	2
1	1989	NO. FATAL	0
6	1990	NO. PDO	10
0	1991	Pers Inj = 2	
12	TOTAL	NIGHTIME	50%

TYPES	NUMBER	ROAD	
ANGLE	0	DRY	92%
REAR END	5	WET	8%
SIDESWIPE	3	SNOW	0%
LEFT TRN	1	ICE	0%
OTHER	3	OTHER	0%



CENTRAL AVENUE, LOOKING WEST



4TH STREET, LOOKING SOUTH



CENTRAL AVENUE, LOOKING EAST



4TH STREET, LOOKING NORTH

TRAFFIC OPERATIONS

The intersection of Central Avenue and 4th Street is a signalized intersection which is part of the Central Avenue corridor signal system using pole top mounted, corner signals. Problems associated with this intersection are typical of other intersections on Central. The signal locations are not within the required cone of vision and are easily hidden from approaching traffic by turning and parked trucks.

IMPROVEMENTS

Accident statistics at this intersection indicate that the predominant accident type is rearend accidents, with five of the 12 total accidents. Three of the accidents were sideswipe accidents and the remainder were of various types including a left turn accident. Because no real benefits could be realized by improvements other than work on the existing signals and such work would necessarily involve installation of new poles and mast arms according to MUTCD standards, it is recommended that a new signal installation be designed and installed at this intersection. This should be completed in conjunction without corridor improvements as outlined in the main body of this report.

Final implementation of these improvements is entirely dependent upon additional study of this intersection. Traffic signal warrants were completed for this intersection. A summary of the warrant analysis is located at the end of this section. Based on this study's traffic counts, the existing signal is not currently warranted. However, pedestrian volumes were lower than what may normally occur at this location. Further traffic count and pedestrian studies should be considered prior to implementing these improvements. However, removal of this signal may not be as easy or desirable as at other intersections on Central since this intersection is in the core of the CBD with signals at each intersection adjacent to it. Very compelling reasons would be necessary to actually remove this signal.

CENTRAL AVENUE & 4TH STREET

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	2000
SOUTH APP	2100
EAST APP	6200
WEST APP	5300

EXISTING CONTROL:

NONE	
YIELD	
STOP	
SIGNAL	YES

RECOMMENDED CONTROL:

PARKING	
YEILD	
STOP	
SIGNAL	YES
MARKING	
GUIDANCE	
REGULATORY	YES

ESTIMATED COST:

TOTAL	\$58,520
MDoT FUND	\$1,120
CITY FUND	\$57,400

% ACCIDENT REDUCTION:

INJ/FTL	20%
PDO	21%

BENEFIT/COST RATIO:

0.55

	INDEX VALUE	SITE RANK
# ACCIDENTS	72	7
ACCIDENT RATE	29	19
SEVERITY	43	18
VOL/CAPACITY	45	13
SIGHT DIST.	56	18
DRIVER EXPECT	67	9
INFO DEFICIENT	75	7
HAZARD INDEX	52.8	18
B/C RATIO	0	25

PRIORITY	35.38	24
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**TRAFFIC SIGNAL WARRANT ANALYSIS
YEAR 1991
CENTRAL AVE & 4TH ST., GREAT FALLS**

WARRANT #1 - MINIMUM VEHICULAR VOLUME					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
		600	200	440	150
% OF WARRANT MET				73%	75%

WARRANT #2 - INTERRUPTION OF CONTINUOUS TRAFFIC					
70% WARRANT		REQUIRED		EXISTS	
YES	NO	MAJOR	MINOR	MAJOR	MINOR
		900	100	440	150
% OF WARRANT MET				49%	150%

WARRANT #3 - MINIMUM PEDESTRIAN TRAFFIC					
50% WARRANT		REQUIRED		EXISTS	
YES	NO	PEDS	GAPS	PEDS	GAPS
		100	60	80	35
		190	60	120	25
% OF WARRANT MET				63%	240%

WARRANT #4 - SCHOOL CROSSING [STUD	YES	NO
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WARRANT #5 - PROGRESSIVE MOVEMENT	YES	NO
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WARRANT #6 - ACCIDENT EXPERIENCE	YES	NO
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WARRANT #7 - SYSTEMS WARRANT	YES	NO
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WARRANT #8 - COMBINATION OF WARRANTS				
80 % OF WARRANTS #1 & #2	REQUIRED		EXISTS	
	MAJOR	MINOR	MAJOR	MINOR
WARRANT #1	480	160	440	150
WARRANT #2	720	80	440	150
% OF WARRANT MET			76%	141%

WARRANT #9 - FOUR HOUR VOLUMES				
	MAJOR	MINOR	CURVE NO.	WARRAN
4TH HIGHEST HOUR	560	200	FIGURE	YES
NUMBER OF LANES	2	2	4.7	NO

WARRANT #10 - PEAK HOUR DELAY				
PEAK HOUR:	MINOR LEG		TOTAL ENTERING	
	DELAY	VOLUME	4 LEGS	3 LEGS
REQUIRED VALUES	4	100	800	650
EXISTING VALUES	1	240	930	

WARRANT #11 - PEAK HOUR VOLUME				
	MAJOR	MINOR	CURVE NO.	WARRAN
PEAK HOUR	700	120	FIGURE	YES
NUMBER OF LANES	1	1	4.5	NO

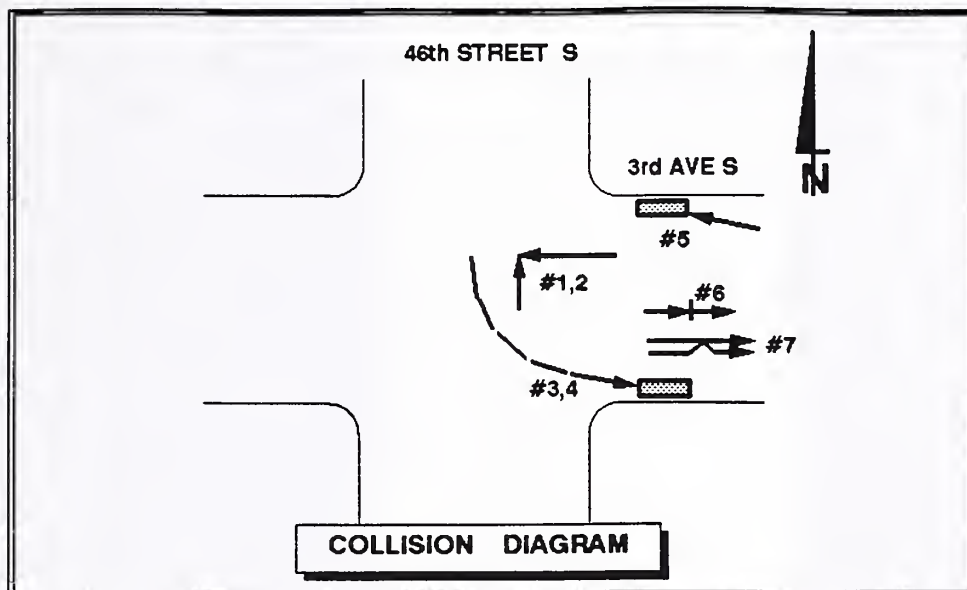
SUMMARY OF WARRANTS SATISFIED					
WARRANT 1		WARRANT 5		WARRANT 9	
WARRANT 2		WARRANT 6		WARRANT 10	
WARRANT 3		WARRANT 7		WARRANT 11	
48x WARRANT 4		WARRANT 8		TOTAL =	0

**SITE
NUMBER**

25

**3RD AVENUE S.
and
46TH STREET S.**

ACCIDENT SUMMARY THIRD AVE S & 46TH STREET S



ACC NO.	ACCIDENT TYPE	ACCIDENT KEY							
		MO.	DAY	YEAR	TIME	SEVERITY	WEATHER	ROAD	LIGHT
1	ANGLE	2	24	89	751	PROP DAM	CLEAR	DRY	DAY
2	ANGLE	2	24	89	1621	PROP DAM	CLEAR	DRY	DAY
3	PARKED CAR	8	12	89	?	PROP DAM	CLEAR	DRY	NITE
4	PARKED CAR	10	14	90	1526	PROP DAM	CLEAR	DRY	DAY
5	PARKED CAR	1	23	88	1001	PROP DAM	CLEAR	DRY	DAY
6	REAREND	1	31	90	759	PROPDAM	CLEAR	ICY	DAY
7	SIDESWIPE	1	5	89	759	PROP DAM	RAIN	WET	DAY

ACCIDENT STATISTICS

NO.			
ACC.	YEAR		
1	1988	NO. INJURY	0
4	1989	NO. FATAL	0
2	1990	NO. PDO	7
0	1991	Pers Inj = 0	
7	TOTAL	NIGHTTIME	0%

TYPES	NUMBER	ROAD	
ANGLE	2	DRY	71%
REAR END	1	WET	14%
SIDESWIPE	1	SNOW	0%
LEFT TURN	0	ICE	14%
OTHER	3	OTHER	0%



THIRD AVENUE S, LOOKING EAST



THIRD AVENUE S, LOOKING WEST



THIRD AVENUE S, LOOKING EAST



FOURTH STREET S, LOOKING NORTH

TRAFFIC OPERATIONS

The intersection of 3rd Avenue S. and 46th Street South is located on the eastern edge of Great Falls. In the general area of the intersection there are apartments on the south side and empty fields on the north side of 3rd Avenue. Traffic volumes are higher on 3rd Avenue than on 3rd Street, but the south approach has an ADT very close to that of 3rd Avenue. The only traffic control devices currently at this intersection are stop signs on 46th Street. A general site observation indicates that parking along the south side of 3rd inhibits required sight distance for vehicles entering from 46th in a northbound direction. Speeds on 3rd would have an 85 percentile of approximately 35 mph.

IMPROVEMENTS

There were 2 angle accidents and 3 parked car type accidents at this intersection. The angle accidents involved drivers that had failed to stop prior to entering the intersection. This would indicate that the highest priority improvement should be installing oversize stop signs to assist drivers who would enter the intersection without stopping by improving visual information. The side street approach conditions should be improved by marking a short section of centerline preceding the stop bar. This will provide additional reinforcement of the stop condition to drivers approaching the intersection.

Measured intersection sight distance based on vehicle speed also indicates the need to further restrict parking on the south side of 3rd Street. Signing and curb marks should be used in this case. This will also alleviate problems with parked car accidents in this area.

THIRD AVENUE S. & 46TH STREET S.

SITE DATA SUMMARY

TRAFFIC VOLUMES:

	ADT
NORTH APP	1900
SOUTH APP	2100
EAST APP	2500
WEST APP	2400

EXISTING CONTROL:

NONE	
YIELD	
STOP	YES
SIGNAL	

RECOMMENDED CONTROL:

PARKING	
YEILD	
STOP	YES
SIGNAL	
MARKING	YES
GUIDANCE	YES
REGULATORY	

ESTIMATED COST:

TOTAL	\$2,100
MDOT FUND	\$1,080
CITY FUND	\$1,020

% ACCIDENT REDUCTION:

INJ/FTL	0%
PDO	33%

BENEFIT/COST RATIO:

1.45

	INDEX VALUE	SITE RANK
# ACCIDENTS	58	18
ACCIDENT RATE	29	18
SEVERITY	34	25
VOL/CAPACITY	58	8
SIGHT DIST.	100	6
DRIVER EXPECT	54	22
INFO DEFICIENT	54	17
HAZARD INDEX	48.8	23
B/C RATIO	8	23

PRIORITY	35.34	25
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